

Periodontal Resource List



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Periodontal Literature List

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1. Gross anatomy, ultrastructural anatomy, and histology

1.1 Gingival epithelium and oral mucosa

Questions to be answered from this section:

- What is the characteristic of the gingiva?
- What is the variation in the width of gingiva?
- How do you measure the thickness of gingiva?
- What are the different periodontal phenotypes?
- Is stippling an indicator of periodontal health?
- What is retrocuspid papilla?

General anatomical features:

1. Ainamo J, Loe H. Anatomical characteristics of the gingiva. A clinical and microscopic study of the free and attached gingiva. *J Periodontol* 1966;37:5-13. DOI: 10.1902/jop.1966.37.1.5 PMID: 4955513

Width of attached gingiva:

2. Bowers GM. A study of the width of the attached gingiva. *J Periodontol* 1963;34:201-209. DOI: 10.1902/jop.1963.34.3.201
3. Ainamo J, Talari A. The increase with age of the width of attached gingiva. *J Periodont Res* 1976;11:182-188. DOI: 10.1111/j.1600-0765.1976.tb00069.x PMID: 133223
4. Voigt JP, Goran ML, Fleisher RM. The width of lingual mandibular attached gingiva. *J Periodontol* 1978;49:77-80. DOI: 10.1902/jop.1978.49.2.77 PMID: 276595

Thickness of attached gingiva:

5. Goaslind GD, Robertson PB, Mahan CJ, Morrison WW, Olson JV. Thickness of facial gingiva. *J Periodontol* 1977;48:768-771. DOI: 10.1902/jop.1977.48.12.768 PMID: 271223
6. Eger T, Muller HP, Helnecke A. Ultrasonic determination of gingival thickness. Subject variation and influence of tooth type and clinical features. *J Clin Periodontol* 1996; 23, 839-845.DOI: 10.1111/j.1600-051x.1996.tb00621.x PMID: 8891935

Periodontal phenotypes:

7. Olsson M, Lindhe J, Marinello CP. On the relationship between crown form and clinical features of the gingiva in adolescents. *J Clin Periodontol* 1993; 20, 570-577. DOI: 10.1111/j.1600-051x.1993.tb00773.x PMID: 7691897
8. Muller HP, Eger T. Gingival phenotypes in young male adults. *J Clin Periodontol* 1997; 24, 65- 71. DOI: 10.1111/j.1600-051x.1997.tb01186.x PMID: 9049800
9. De Rouck T, Eghbali R, Collys K, De Bruyn H, Cosyn J. The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingiva. *J Clin Periodontol* 2009;36:428-33. DOI: 10.1111/j.1600-051X.2009.01398.x PMID: 19419444

Stippling:

10. Owings JR. A clinical investigation of the relationship between stippling and surface keratinization of the attached gingiva. *J Periodontol* 1969;40:588-592. DOI:10.1902/jop.1969.40.10.588 PMID: 5260095
11. Karring T, Loe HB. The three-dimensional concept of the epithelium-connective tissue boundary of gingiva. *Acta Odontol Scand* 1970;28:917-933. DOI: 10.3109/00016357009028255 PMID: 5277416

Papillae/Retrocuspid papilla:

12. Holmes, C.H.: Morphology of the interdental papillae. *J Periodontol* 1965; 36:455-460. DOI: 10.1902/jop.1965.36.6.455 PMID: 5214409
13. Buchner A, Merrell PW, Hansen LS, Leider AS. The retrocuspid papilla of the mandibular lingual gingiva. *J Periodontol* 1990;61:585-9. DOI: 10.1902/jop.1990.61.9.585 PMID: 2213469

Pigmentation:

Ho DK, Ghinea R, Herrera LJ, Angelov N, Paravina RD. Color Range and Color Distribution of Healthy Human Gingiva: a Prospective Clinical Study. *Sci Rep.* 2015; 22;5:18498. DOI: 10.1038/srep18498. PMID: 26691598.

Gingival characteristics in children:

Wyrębek B, Orzechowska A, Cudził D, Plakwicz P. Evaluation of changes in the width of gingiva in children and youth. Review of literature. *Dev Period Med.* 2015;19(2):212-6. PMID: 26384125.

Reviews:

14. Hassell T, M. Tissues and cells of the periodontium. *Periodontology 2000* 1993;3:9-38. DOI: 10.1111/j.1600-0757.1993.tb00230.x PMID: 9673156
15. Schroeder HE, Listgarten MA. The gingival tissues: the architecture of periodontal protection. *Periodontology 2000* 1997;13:91-120. DOI: 10.1111/j.1600-0757.1997.tb00097.x PMID: 9567925
16. Müller HP, Eger T. Masticatory mucosa and periodontal phenotype: A review. *Int J Periodont Restorative Dent* 2002;22:2:173-183. PMID: 12019713

1.2 Dentogingival Complex

Questions to be answered from this section:

- What is the microscopic anatomy of gingival epithelium?
- What is the microscopic structure of dentogingival complex?
- What comprises gingival vasculature?

Epithelia:

1. Schroeder H, Theilade J. Electron microscopy of normal human gingival epithelium. *J Periodont Res* 1966;1:95-119. DOI: 10.1111/j.1600-0765.1966.tb01850.x. PMID: 4225000
2. Squier CA, Waterhouse JP. The ultrastructure of the melanocyte in human gingival epithelium. *Archs Oral Biol* 1967;12:119-129. DOI: 10.1111/j.1365-2818.1969.tb00665.x
3. Thilander H, Bloom GD. Cell contacts in oral epithelia. *J Periodont Res* 1968;3:96-110. DOI: 10.1111/j.1600-0765.1968.tb01909.x. PMID: 4249993
4. Susi FR. Anchoring fibrils in the attachment of epithelium to connective tissue in oral mucous membranes. *J Dent Res* 1969;48:144-148. DOI: 10.1177/00220345690480010701. PMID: 5252087
5. McHugh WD. The interdental gingivae. *J Periodontal Res* 1971; 6, 227-236. DOI: 10.1111/j.1600-0765.1971.tb00613.x. PMID: 4272016
6. Taylor A, Campbell M. Reattachment of gingival epithelium to the tooth. *J Periodontol* 1972; 43:281-293. DOI: 10.1902/jop.1972.43.5.281. PMID: 4623949
7. Kobayashi K, Rose G, Mahan C. Ultra-structure of the dento-epithelial junction. *J Periodont Res* 1976;11:313-330. DOI: 10.1111/j.1600-0765.1976.tb00086.x. PMID: 135827
8. Squier CA. Keratinization of the sulcular epithelium - a pointless pursuit? *J Periodontol* 1981;52:426-429. DOI: 10.1902/jop.1981.52.8.426 PMID: 6167706
9. Newcomb GM, Seymour GJ, Powell RN. Association between plaque accumulation and Langerhans cell numbers in the oral epithelium of attached gingiva. *J Clin Periodontol* 1982; 9:297-304. DOI: 10.1111/j.1600-051x.1982.tb02096.x. PMID: 6964677
10. Hormia M, Owaribe K, Virtanen I. The dento-epithelial junction: cell adhesion by type I hemidesmosomes in the absence of a true basal lamina. *J Periodontol* 2001;72:788-97. DOI: 10.1902/jop.2001.72.6.788 PMID: 11453242
11. Locke M, Hyland PL, Irwin CR, Mackenzie IC. Modulation of gingival epithelial phenotypes by interactions with regionally defined populations of fibroblasts. *J Periodontal Res* 2008;43:279-89. DOI: 10.1111/j.1600-0765.2007.01028.x. PMID: 18447855

12. Gargiulo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans. *J Periodontol* 1961;32:261-267. DOI: 10.1902/jop.1961.32.3.261
13. Listgarten M. Electron microscopic study of the gingivodental junction in man. *Amer J Anat* 1966; 119:149. DOI: 10.1002/aja.1001190109 PMID: 5967891
14. Listgarten M. Changing concepts about the dento-epithelial junction. *JCD A* 1970; 36:70-75. PMID: 5263919
15. Listgarten M. Ultrastructure of the dentogingival junction after gingivectomy. *J Periodont Res* 1972;7:151-160. DOI: 10.1111/j.1600-0765.1972.tb00640.x PMID: 4272041
16. Vacek JS, Gher ME, Assad DA, Richardson AC, Giambarresi LI. The dimensions of the human dentogingival junction. *Int J Periodontics Restorative Dent* 1994; 14:154-165. PMID: 7928131
17. Kobayashi K, Rose G. Ultrastructure of the dento-epithelial junction. *J Perio Res* 1976; 11:313-330. DOI: 10.1111/j.1600-0765.1976.tb00086.x. PMID: 135827
18. Stern I. Current concepts of the dentogingival junction: The epithelial and connective tissue attachment to the tooth. *J Periodontol* 1981; 52:465-476. DOI: 10.1902/jop.1981.52.9.465 PMID: 7026753
19. Caffesse, R.G., et al.: The effect of mechanical stimulation on the keratinization of sulcular epithelium. *J Periodontol* 53:89-92, 1982. DOI: 10.1902/jop.1982.53.2.89 PMID: 6174721

Vasculation:

20. Egelberg J. The blood vessels of the dento-gingival junction. *J Periodontal Res* 1966;1:163-179.DOI: 10.1111/j.1600-0765.1966.tb01857.x PMID: 4225527
21. Carranza FA Jr, Itoiz ME, Cabrini RL, Dotto CA. A study of periodontal vascularization in different laboratory animals. *J Periodontal Res* 1966;1:120-8. DOI: 10.1111/j.1600-0765.1966.tb01851.x. PMID: 4225043
22. Levy BM, Bernick S. Studies on the biology of the periodontium of marmosets: V. Lymphatic vessels of the periodontal ligament. *J Dent Res* 1968;47:1166-1170. DOI: 10.1177/00220345680470062601. PMID: 4973665
23. Mörmann W, Meier C, Firestone A. Gingival blood circulation after experimental wounds in man. *J Clin Periodontol* 1979;6:417-24. DOI: 10.1111/j.1600-051x.1979.tb01940.x. PMID: 295289
24. Scardina GA, Fucà G, Messina P. Microvascular characteristics of the human interdental papilla. *Anat Histol Embryol* 2007;36:266-8. DOI: 10.1111/j.1439-0264.2006.00756.x PMID: 17617103

Innervation:

25. Byers MR, Dong WK. Comparison of trigeminal receptor location and structure in the periodontal ligament of different types of teeth from the rat, cat, and monkey. *J Comp Neurol* 1989;279:117- 127. DOI: 10.1002/cne.902790110 PMID: 2492311
26. Lambrechts I, Creemers J, van Steenberghe D. Morphology of neural endings in the human periodontal ligament: an electron microscopic study. *J Periodontal Res* 1992;27:191-196. DOI: 10.1111/j.1600-0765.1992.tb01668.x PMID: 1608032
27. Nakamura TK, Nakahara H, Nakamura M, Kiyomura H, Tokioka T. Fine structure of adrenergic nerve fibers in human periodontal ligament. *J Periodontal Res* 1992;27:569-574. DOI: 10.1111/j.1600-0765.1992.tb01738.x PMID: 1460545
28. Fantini F, Giannetti A, Benassi L, Cattaneo V, Magnoni C, Pincelli C. Nerve growth factor receptor and neurochemical markers in human oral mucosa: an immunohistochemical study. *Dermatology* 1995;190:186-91. DOI: 10.1159/000246682 PMID: 7541261

Reviews:

29. Nuki K, Hock J. The organization of the gingival vasculature. *J Perio Res* 1974; 9:305-313. DOI: 10.1111/j.1600-0765.1974.tb00686.x PMID: 4281826
30. Hassell T, M. Tissues and cells of the periodontium. *Periodontology 2000* 1993;3:9-38. Pages 11-16 DOI: 10.1111/j.1600-0757.1993.tb00230.x PMID: 9673156

31. Schroeder HE, Listgarten MA. The gingival tissues: the architecture of periodontal protection. *Periodontology 2000* 2000;13:91-120. Pages 101-111 DOI: 10.1111/j.1600-0757.1997.tb00097.x PMID: 9567925

1.3 PDL

Questions to be answered from this section: What is the microstructure of PDL?

1. Coolidge ED. The thickness of the human periodontal membrane. *J Am Dent Assoc* 1937;24:1260-1270. DOI: 10.14219/jada.archive.1937.0229
2. Bevelander G, Nakahara H. The fine structure of the human peridental ligament. *Anat Rec* 1968;162:313-326. DOI: 10.1002/ar.1091620306 PMID: 5702218
3. Spouge J. A new look at the rests of Malassez. A review of their embryological origin, anatomy, and possible role in periodontal health and disease. *J Periodontol* 1980; 51:437-444. DOI: 10.1902/jop.1980.51.8.437 PMID: 6931203
4. Plecash JM, Bentley JP. Crosslink analysis as an indicator of collagen turnover in periodontal ligament from functioning and non-functioning teeth in the dog. *Arch Oral Biol* 1982;27:463-468. DOI: 10.1016/0003-9969(82)90085-1 PMID: 6956258
5. McCulloch CAG, Melcher AH. Cell density and cell generation in the periodontal ligament of mice. *Am J Anat* 1983;167:43-58. DOI: 10.1002/aja.1001670105 PMID: 6869309
6. Somerman M, Foster R, Imm G, Sauk J, Archer S. Periodontal ligament cells and gingival fibroblasts respond differently to attachment factors. *J Periodontol* 1989; 60:73-77. DOI: 10.1902/jop.1989.60.2.73 PMID: 2724026
7. Mariotti A, Cochran DL. Characterization of fibroblasts derived from human periodontal ligament and gingiva. *J Periodontol* 1990; 61:103-111. DOI: 10.1902/jop.1990.61.2.103 PMID: 2313526
8. Arceo N, Sauk JJ, Moehring J, Foster RA, Somerman MJ. Human periodontal cells initiate mineral-like nodules in vitro. *J Periodontol* 1991;62:499-503. DOI: 10.1902/jop.1991.62.8.499 PMID: 1920017
9. Johnson RB, Pylypas SP. A re-evaluation of the distribution of the elastic meshwork within the periodontal ligament of the mouse. *J Periodont Res* 1992;27:239-249. DOI: 10.1111/j.1600-0765.1992.tb01674.x PMID: 1640346
10. Ogata Y, Niisato N, Sakurai T, Furuyama S, Sugiya H. Comparison of the characteristics of human gingival fibroblasts and periodontal ligament cells. *J Periodontol* 1995; 66:1025-1031. DOI: 10.1902/jop.1995.66.12.1025 PMID: 8683414
11. Reichenberg E, Redlich M, Cancemi P, et al. Proteomic analysis of protein components in periodontal ligament fibroblasts. *J Periodontol* 2005;76:1645-53. DOI: 10.1902/jop.2005.76.10.1645 PMID: 16253085
12. Nagatomo K, Komaki M, Sekiya I, et al. Stem cell properties of human periodontal ligament cells. *J Periodontal Res* 2006;41:303-10. DOI: 10.1111/j.1600-0765.2006.00870.x PMID: 16827724

Reviews:

13. Embery G. An update on the biochemistry of the periodontal ligament. *Eur J Orthod* 1990;12:77- 80. DOI: 10.1093/ejo/12.1.77 PMID: 2180729
14. Hassell T, M. Tissues and cells of the periodontium. *Periodontology 2000* 1993;3:9-38. Pages 23-30. DOI: 10.1111/j.1600-0757.1993.tb00230.x PMID: 9673156
15. Beertsen W, McCulloch CA, Sodek J. The periodontal ligament: a unique, multifunctional connective tissue. *Periodontol 2000* 1997;13:20-40. DOI: 10.1111/j.1600-0757.1997.tb00094.x PMID: 9567922

1.4 Cementum

Questions to be answered from this section:

- What is the microstructure of cementum?
- What are age-related changes in cementum?

1. Selvig K. The fine structure of human cementum. *Acta Odontol Scand* 1965; 23:423-441. PMID: 5214199 DOI: 10.3109/00016356509007523
2. Stahl S. The nature of healthy and diseased root surfaces. *J Periodontol* 1975; 46:156-161. PMID: 1054759 DOI: 10.1902/jop.1975.46.3.156
3. Daly C, Seymour G. Histological assessment of periodontally involved cementum. *J Clin Periodontol* 1982; 9:266-274. PMID: 6178759 DOI: 10.1111/j.1600-051x.1982.tb02066.x
4. Nakib N, Bissada N. Endotoxin penetration into root cementum of periodontally healthy and diseased human teeth. *J Periodontol* 1982; 53:368-378. PMID: 7050340 DOI: 10.1902/jop.1982.53.6.368
5. Bartold PM, Miki Y, McAllister B, Narayanan AS, Page RC. Glycosaminoglycans of human cementum. *J Periodont Res* 1988; 23:13-17. PMID: 2963899 DOI: 10.1111/j.1600-0765.1988.tb01020.x
6. Slavkin HC, Bringas P, Jr., Bessem C, et al. Hertwig's epithelial root sheath differentiation and initial cementum and bone formation during long-term organ culture of mouse mandibular first molars using serumless, chemically-defined medium. *J Periodont Res* 1989;24:28-40. PMID: 2524567 DOI: 10.1111/j.1600-0765.1989.tb00854.x
7. Becker J, Schuppan D, Rabanus JP, Rauch R, Niechoy U, Gelderblom HR. Immunoelectron microscopic localization of collagens type I, V, VI and of procollagen type III in human periodontal ligament and cementum. *J Histochem Cytochem* 1991;39:103-110. PMID: 1983870 DOI: 10.1177/39.1.1983870
8. Tenorio D, Cruchley A, Hughes FJ. Immunocytochemical investigation of the rat cementoblast phenotype. *J Periodont Res* 1993;28:411-419. PMID: 8254458
9. Kagerer P, Grupe G. Age-at-death diagnosis and determination of life-history parameters by incremental lines in human dental cementum as an identification aid. *Forensic Sci Int* 2001;118:75-82. PMID: 11343858 DOI: 10.1016/s0379-0738(00)00382-0
10. Pinchi V, Forestieri AL, Calvitti M. Thickness of the dental (radicular) cementum: a parameter for estimating age. *J Forensic Odontostomatol* 2007;25:1-6. PMID: 17580382

Reviews:

11. Hassell T, M. Tissues and cells of the periodontium. *Periodontology* 2000 1993;3:9-38. PMID: 9673156 DOI: 10.1111/j.1600-0757.1993.tb00230.x
12. Mariotti A. The extracellular matrix of the periodontium: dynamic and interactive tissues. *Periodontology* 2000 1993;3:39-63. PMID: 9673157 DOI: 10.1111/j.1600-0757.1993.tb00231.x
13. Bosshardt DD, Selvig KA. Dental cementum: the dynamic tissue covering of the root. *Periodontology* 2000 1997;13:41-75. PMID: 9567923 DOI: 10.1111/j.1600-0757.1997.tb00095.x
14. Saygin N, Giannobile W, Somerman M. Molecular and cell biology of cementum. *Periodontology* 2000, 2000; 24:73-98. PMID: 11276875 DOI: 10.1034/j.1600-0757.2000.2240105.x

1.5 Alveolar Bone

Questions to be answered from this session:

- What is the microstructure of alveolar bone?
- How common are dehiscence and fenestrations in alveolar bone?
- How does alveolar bone heal?

Alveolar Bone Anatomy

1. Ritchey B, Orban B. The crests of the interdental alveolar septa. *J Periodontol* 1953;24:75-87. DOI:10.1902/JOP.1953.24.2.75
2. Parfitt GJ. An investigation of the normal variations in alveolar bone trabeculation. *Oral Surg Oral Med Oral Pathol* 1962;15:1453-1463. PMID: 13941409 DOI: 10.1016/0030-4220(62)90409-7
3. Elliot R, Bowers G. Alveolar dehiscence and fenestration. *Periodontics* 1963;1:245-248.

4. Larato DC. Alveolar plate fenestrations and dehiscences of the human skull. *Oral Surg Oral Med Oral Pathol* 1970;29:816-819. PMID: 5267621 DOI: 10.1016/0030-4220(70)90429-9
5. Lost C. Depth of alveolar bone dehiscences in relation to gingival recessions. *J Clin Periodontol* 1984;11:583-589. PMID: 6593330 DOI: 10.1111/j.1600-051x.1984.tb00911.x
6. Becker W, Ochsenbein C, Tibbetts L, Becker BE. Alveolar bone anatomic profiles as measured from dry skulls. Clinical ramifications. *J Clin Periodontol* 1997;24:727-31. PMID: 9350556 DOI: 10.1111/j.1600-051x.1997.tb00189.x
7. Rupprecht RD, Horning GM, Nicoll BK, Cohen ME. Prevalence of dehiscences and fenestrations in modern American skulls. *J Periodontol.* 2001;72:722-9. PMID: 11453233 DOI: 10.1902/jop.2001.72.6.722

Alveolar Bone Remodeling

8. Boyne PJ. Osseous repair of the postextraction alveolus in man. *Oral Surg Oral Med Oral Pathol* 1966;21:805-813. PMID: 5219671 DOI: 10.1016/0030-4220(66)90104-6
9. Nobuto T, Yanagihara K, Teranishi Y, Minamibayashi S, Imai H, Yamaoka A. Periosteal microvasculature in the dog alveolar process. *J Periodontol* 1989;60:709-715. PMID: 2614635 DOI: 10.1902/jop.1989.60.12.709
10. Trombelli L, Farina R, Marzola A, Bozzi L, Liljenberg B, Lindhe J. Modeling and remodeling of human extraction sockets. *J Clin Periodontol* 2008;35:630-9. PMID: 18498382 DOI: 10.1111/j.1600-051X.2008.01246.x

Reviews:

11. Saffar JL, Lasfarques JJ, Cherruau M. Alveolar bone and the alveolar process: the socket that is never stable. *Periodontology 2000* 1997;13:76-90. PMID: 9567924 DOI: 10.1111/j.1600-0757.1997.tb00096.x
12. Zernik JH, Nowroozi N, Liu YH, Maxson R. Development, maturation, and aging of the alveolar bone. New insights. *Dent Clin North Am* 1997;41(1):1-15. PMID: 9023059
13. Sodek J, McKee MD. Molecular and cellular biology of alveolar bone. *Periodontol 2000* 2000;24:99-126. PMID: 11276877 DOI: 10.1034/j.1600-0757.2000.2240106.x

2. Microbiology, etiology, risk factors, histopathology, and pathogenesis

Questions to be answered from this section:

- What are the main differences in composition of subgingival microbial flora between periodontally healthy and diseased sites?
- Describe different methods for identifying bacteria associated with periodontal diseases. What are their advantages and disadvantages?
- What are the predominant periodontal pathogens identified in the classic literature? Is there unique bacteriology associated with pregnancy and necrotizing periodontal diseases?
- What is the difference between plaque (biofilm) and microbiome? What does dysbiosis mean?
- Describe the nature history of periodontal diseases in man in terms of progression rate and pattern.
- Do periodontal therapy and maintenance change the clinical course of periodontal disease?
- What is the primary etiology of periodontal disease?
- What are the roles of bacteria in the pathogenesis of periodontal disease?
- What are the roles of host response in the pathogenesis of periodontal disease?
- Which enzymes and cytokines are involved in periodontal disease progression?
- What is the role of histopathology in diagnosis and prognosis of periodontal disease?
- Describe the local factors that could contribute to the pathogenesis of periodontal disease.
- What are the mechanisms of action of cigarette smoking in periodontal diseases? Are they dose-dependent?
- What is the impact of cigarette smoking on periodontal therapy?
- What are the benefits of smoking cessation? Does the length of smoking cessation matter?
- What are the association of other environmental factors such as stress and alcohol consumption with

periodontal diseases?

- What are the potential mechanisms by which diabetes mellitus affects periodontal diseases?
- What are the potential mechanisms by which periodontal disease affects diabetes mellitus?
- Does patient's glycemic control influence the outcome of periodontal therapy? Does periodontal therapy influence glycemic control?
- What are the association between periodontal disease and other systemic factors such as obesity, pregnancy/hormonal change, medication, CVD, osteoporosis, rheumatoid arthritis, age, and metabolic syndrome?
- How can genetics contribute to periodontal disease?
- What is genotype? What are single nucleotide polymorphisms (SNPs)? How do they contribute to pathogenesis of periodontal disease?
- What is epigenetics and how does it contribute to pathogenesis of periodontal disease?
- What are the differences between infection and inflammation?
- What are the differences between innate and adaptive immunity?
- Provide some examples of the protective and destructive roles of host immune system in the periodontal disease.

2.1 Plaque and microbiology

1. Loe H, Theilade E, Jensen SB. Experimental gingivitis in Man. *J Periodontol (1930)*. 1965 May-Jun;36:177-87. doi: 10.1902/jop.1965.36.3.177. PMID: 14296927.
2. Theilade E, Wright WH, Jensen SB, Löe H. Experimental gingivitis in man. II. A longitudinal clinical and bacteriological investigation. *J Periodontal Res*. 1966;1:1-13. doi: 10.1111/j.1600-0765.1966.tb01842.x. PMID: 4224181.
3. Listgarten MA. Structure of the microbial flora associated with periodontal health and disease in man. A light and electron microscopic study. *J Periodontol*. 1976 Jan;47(1):1-18. doi: 10.1902/jop.1976.47.1.1. PMID: 1063849.
4. Listgarten MA, Helldén L. Relative distribution of bacteria at clinically healthy and periodontally diseased sites in humans. *J Clin Periodontol*. 1978 May;5(2):115-32. doi: 10.1111/j.1600-051x.1978.tb01913.x. PMID: 350909.
5. Kornman KS, Loesche WJ. The subgingival microbial flora during pregnancy. *J Periodontal Res*. 1980 Mar;15(2):111-22. doi: 10.1111/j.1600-0765.1980.tb00265.x. PMID: 6103927.
6. Loesche WJ, Syed SA, Laughon BE, Stoll J. The bacteriology of acute necrotizing ulcerative gingivitis. *J Periodontol*. 1982 Apr;53(4):223-30. doi: 10.1902/jop.1982.53.4.223. PMID: 6122728.
7. Zambon JJ. Actinobacillus actinomycetemcomitans in human periodontal disease. *J Clin Periodontol*. 1985 Jan;12(1):1-20. doi: 10.1111/j.1600-051x.1985.tb01348.x. PMID: 3882766.
8. Christersson LA, Slots J, Zambon JJ, Genco RJ. Transmission and colonization of Actinobacillus actinomycetemcomitans in localized juvenile periodontitis patients. *J Periodontol*. 1985 Mar;56(3):127-31. doi: 10.1902/jop.1985.56.3.127. PMID: 3857321.
9. Listgarten MA, Schifter CC, Sullivan P, George C, Rosenberg ES. Failure of a microbial assay to reliably predict disease recurrence in a treated periodontitis population receiving regularly scheduled prophylaxes. *J Clin Periodontol*. 1986 Sep;13(8):768-73. doi: 10.1111/j.1600-051x.1986.tb00880.x. PMID: 3464622.
10. Theilade E. The non-specific theory in microbial etiology of inflammatory periodontal diseases. *J Clin Periodontol*. 1986 Nov;13(10):905-11. doi: 10.1111/j.1600-051x.1986.tb01425.x. PMID: 3540019.
11. Dzink JL, Socransky SS, Haffajee AD. The predominant cultivable microbiota of active and inactive lesions of destructive periodontal diseases. *J Clin Periodontol*. 1988 May;15(5):316-23. doi: 10.1111/j.1600-051x.1988.tb01590.x. PMID: 3292595.
12. Moore WE, Moore LH, Ranney RR, Smibert RM, Burmeister JA, Schenkein HA. The microflora of periodontal sites showing active destructive progression. *J Clin Periodontol*. 1991 Nov;18(10):729-39. doi: 10.1111/j.1600-051x.1991.tb00064.x. PMID: 1752997.

13. van Steenbergen TJ, Petit MD, Scholte LH, van der Velden U, de Graaff J. Transmission of Porphyromonas gingivalis between spouses. *J Clin Periodontol*. 1993 May;20(5):340-5. doi: 10.1111/j.1600-051x.1993.tb00370.x. PMID: 8388896.
14. Socransky SS, Haffajee AD, Cugini MA, Smith C, Kent RL Jr. Microbial complexes in subgingival plaque. *J Clin Periodontol*. 1998 Feb;25(2):134-44. doi: 10.1111/j.1600-051x.1998.tb02419.x. PMID: 9495612.
15. Tanner A, Maiden MF, Macuch PJ, Murray LL, Kent RL Jr. Microbiota of health, gingivitis, and initial periodontitis. *J Clin Periodontol*. 1998;25(2):85-98. doi:10.1111/j.1600-051x.1998.tb02414.x
16. Kumar PS, Griffen AL, Barton JA, Paster BJ, Moeschberger ML, Leys EJ. New bacterial species associated with chronic periodontitis. *J Dent Res*. 2003;82(5):338-344. doi:10.1177/154405910308200503
17. Kumar PS, Griffen AL, Moeschberger ML, Leys EJ. Identification of candidate periodontal pathogens and beneficial species by quantitative 16S clonal analysis. *J Clin Microbiol*. 2005 Aug;43(8):3944-55. doi: 10.1128/JCM.43.8.3944-3955.2005. PMID: 16081935; PMCID: PMC1233920.
18. Kumar PS, Leys EJ, Bryk JM, Martinez FJ, Moeschberger ML, Griffen AL. Changes in periodontal health status are associated with bacterial community shifts as assessed by quantitative 16S cloning and sequencing. *J Clin Microbiol*. 2006 Oct;44(10):3665-73. doi: 10.1128/JCM.00317-06. PMID: 17021095; PMCID: PMC1594761.
19. Aas JA, Paster BJ, Stokes LN, Olsen I, Dewhirst FE. Defining the normal bacterial flora of the oral cavity. *J Clin Microbiol*. 2005 Nov;43(11):5721-32. doi: 10.1128/JCM.43.11.5721-5732.2005. PMID: 16272510; PMCID: PMC1287824.
20. Haubek D, Ennibi OK, Poulsen K, Vaeth M, Poulsen S, Kilian M. Risk of aggressive periodontitis in adolescent carriers of the JP2 clone of Aggregatibacter (Actinobacillus) actinomycetemcomitans in Morocco: a prospective longitudinal cohort study. *Lancet*. 2008 Jan 19;371(9608):237-42. doi: 10.1016/S0140-6736(08)60135-X. PMID: 18207019.
21. Abusleme L, Dupuy AK, Dutzan N, et al. The subgingival microbiome in health and periodontitis and its relationship with community biomass and inflammation. *ISME J*. 2013;7(5):1016-1025. doi:10.1038/ismej.2012.174
22. Pérez-Chaparro PJ, McCulloch JA, Mamizuka EM, Moraes ADCL, Faveri M, Figueiredo LC, Duarte PM, Feres M. Do different probing depths exhibit striking differences in microbial profiles? *J Clin Periodontol*. 2018 Jan;45(1):26-37. doi: 10.1111/jcpe.12811. Epub 2017 Dec 1. PMID: 28871594.

Reviews:

16. Listgarten MA. The structure of dental plaque. *Periodontol 2000*. 1994 Jun;5:52-65. doi: 10.1111/j.1600-0757.1994.tb00018.x. PMID: 9673162.
17. Slots J, Slots H. Periodontal herpesvirus morbidity and treatment. *Periodontol 2000*. 2019 Feb;79(1):210-220. doi: 10.1111/prd.12241. PMID: 30892761.
18. Haffajee AD, Socransky SS. Microbial etiological agents of destructive periodontal diseases. *Periodontol 2000*. 1994 Jun;5:78-111. doi: 10.1111/j.1600-0757.1994.tb00020.x. PMID: 9673164.
19. Paster BJ, Boches SK, Galvin JL, Ericson RE, Lau CN, Levanos VA, Sahasrabudhe A, Dewhirst FE. Bacterial diversity in human subgingival plaque. *J Bacteriol*. 2001 Jun;183(12):3770-83. doi: 10.1128/JB.183.12.3770-3783.2001. PMID: 11371542; PMCID: PMC95255.
20. Lamont RJ, Koo H, Hajishengallis G. The oral microbiota: dynamic communities and host interactions. *Nat Rev Microbiol*. 2018 Dec;16(12):745-759. doi: 10.1038/s41579-018-0089-x. PMID: 30301974; PMCID: PMC6278837

2.2 Natural history and pathogenesis of periodontal disease

1. Hirschfeld L, Wasserman B. A long-term survey of tooth loss in 600 treated periodontal patients. *J Periodontol*. 1978 May;49(5):225-37. doi: 10.1902/jop.1978.49.5.225. PMID: 277674.

2. Löe H, Anerud A, Boysen H, Smith M. The natural history of periodontal disease in man. The rate of periodontal destruction before 40 years of age. *J Periodontol*. 1978 Dec;49(12):607-20. doi: 10.1902/jop.1978.49.12.607. PMID: 282430.
3. Becker W, Berg L, Becker BE. Untreated periodontal disease: a longitudinal study. *J Periodontol*. 1979 May;50(5):234-44. doi: 10.1902/jop.1979.50.5.234. PMID: 287779.
4. Goodson JM, Tanner AC, Haffajee AD, Sornberger GC, Socransky SS. Patterns of progression and regression of advanced destructive periodontal disease. *J Clin Periodontol*. 1982 Nov;9(6):472-81. doi: 10.1111/j.1600-051x.1982.tb02108.x. PMID: 6960023.
5. Lindhe J, Haffajee AD, Socransky SS. Progression of periodontal disease in adult subjects in the absence of periodontal therapy. *J Clin Periodontol*. 1983 Jul;10(4):433-42. doi: 10.1111/j.1600-051x.1983.tb01292.x. PMID: 6577035.
6. Socransky SS, Haffajee AD, Goodson JM, Lindhe J. New concepts of destructive periodontal disease. *J Clin Periodontol*. 1984 Jan;11(1):21-32. doi: 10.1111/j.1600-051x.1984.tb01305.x. PMID: 6582072.
7. Becker W, Becker BE, Berg LE. Periodontal treatment without maintenance. A retrospective study in 44 patients. *J Periodontol*. 1984 Sep;55(9):505-9. doi: 10.1902/jop.1984.55.9.505. PMID: 6592322.
8. Löe H, Anerud A, Boysen H, Morrison E. Natural history of periodontal disease in man. Rapid, moderate and no loss of attachment in Sri Lankan laborers 14 to 46 years of age. *J Clin Periodontol*. 1986 May;13(5):431-45. doi: 10.1111/j.1600-051x.1986.tb01487.x. PMID: 3487557.
9. Axelsson P, Lindhe J, Nyström B. On the prevention of caries and periodontal disease. Results of a 15-year longitudinal study in adults. *J Clin Periodontol*. 1991 Mar;18(3):182-9. doi: 10.1111/j.1600-051x.1991.tb01131.x. PMID: 2061418.
10. Van Dyke TE, Lester MA, Shapira L. The Role of the Host Response in Periodontal Disease Progression: Implications for Future Treatment Strategies. *J Periodontol*. 1993 Aug;64 Suppl 8S:792-806. doi: 10.1902/jop.1993.64.8s.792. PMID: 29539752..
11. Rosling B, Serino G, Hellström MK, Socransky SS, Lindhe J. Longitudinal periodontal tissue alterations during supportive therapy. Findings from subjects with normal and high susceptibility to periodontal disease. *J Clin Periodontol*. 2001 Mar;28(3):241-9. doi: 10.1034/j.1600-051x.2001.028003241.x. PMID: 11284537.
12. Page RC, Martin J, Krall EA, Mancl L, Garcia R. Longitudinal validation of a risk calculator for periodontal disease. *J Clin Periodontol*. 2003 Sep;30(9):819-27. doi: 10.1034/j.1600-051x.2003.00370.x. PMID: 12956658.
13. Heitz-Mayfield LJ, Schätzle M, Löe H, Bürgin W, Anerud A, Boysen H, Lang NP. Clinical course of chronic periodontitis. II. Incidence, characteristics and time of occurrence of the initial periodontal lesion. *J Clin Periodontol*. 2003 Oct;30(10):902-8. doi: 10.1034/j.1600-051x.2003.00399.x. PMID: 14710770.
14. Schätzle M, Löe H, Lang NP, Heitz-Mayfield LJ, Bürgin W, Anerud A, Boysen H. Clinical course of chronic periodontitis. III. Patterns, variations and risks of attachment loss. *J Clin Periodontol*. 2003 Oct;30(10):909-18. doi: 10.1034/j.1600-051x.2003.00401.x. PMID: 14710771.
15. Ramseier CA, Anerud A, Dulac M, Lulic M, Cullinan MP, Seymour GJ, Faddy MJ, Bürgin W, Schätzle M, Lang NP. Natural history of periodontitis: Disease progression and tooth loss over 40 years. *J Clin Periodontol*. 2017 Dec;44(12):1182-1191. doi: 10.1111/jcpe.12782. Epub 2017 Sep 22. PMID: 28733997.

Reviews:

16. Page RC, Schroeder HE. Pathogenesis of inflammatory periodontal disease. A summary of current work. *Lab Invest*. 1976 Mar;34(3):235-49. PMID: 765622.
17. Page RC. The role of inflammatory mediators in the pathogenesis of periodontal disease. *J Periodontal Res*. 1991 May;26(3 Pt 2):230-42. doi: 10.1111/j.1600-0765.1991.tb01649.x. PMID: 1679130.
18. Birkedal-Hansen H. Role of cytokines and inflammatory mediators in tissue destruction. *J Periodontal Res*. 1993 Nov;28(6 Pt 2):500-10. doi: 10.1111/j.1600-0765.1993.tb02113.x. PMID: 8263720.
19. Reynolds MA. Modifiable risk factors in periodontitis: at the intersection of aging and disease. *Periodontol 2000*. 2014 Feb;64(1):7-19. doi: 10.1111/prd.12047. PMID: 24320953.

2.3 Histopathology

Questions to be answered in this session:

- What is the molecular mechanism of periodontal disease?
- Which enzymes and cytokines are involved in periodontal disease progression?
- What is the role of histopathology in diagnosis and prognosis of periodontal disease?

Introduction

1. Listgarten M. Clinical trials in periodontitis: pathogenesis of periodontitis. *J Clin Periodontol* 1986;13: 418-430. PMID: 3522650 DOI: [10.1111/j.1600-051x.1986.tb01485.x](https://doi.org/10.1111/j.1600-051x.1986.tb01485.x)
2. Takata T, Donath, K. The mechanism of pocket formation - A light microscopic study of undecalcified human material. *J Periodontol* 1988;59:215. PMID: 3164372 DOI: [10.1902/jop.1988.59.4.215](https://doi.org/10.1902/jop.1988.59.4.215)
3. Kornman K. Mapping the pathogenesis of periodontitis: a new look. *J Periodontol* 2008;79: 1560-1568. PMID: 18673011 DOI: [10.1902/jop.2008.080213](https://doi.org/10.1902/jop.2008.080213)

Enzymes

4. Christner P. Collagenase in the human periodontal ligament. *J Periodontol* 1980;51:455-61. PMID: 6249905 DOI: [10.1902/jop.1980.51.8.455](https://doi.org/10.1902/jop.1980.51.8.455)
5. Villela B, et al. Crevicular fluid collagenase activity in healthy, gingivitis, chronic adult periodontitis and localized juvenile periodontitis patients. *J Periodontol Res* 1987;22:209. PMID: 3037060 DOI: [10.1111/j.1600-0765.1987.tb01569.x](https://doi.org/10.1111/j.1600-0765.1987.tb01569.x)

Inflammation/Polymorphonuclear Leukocyte

6. Saglie R, et al. A scanning electron microscopic study of leukocytes and their interaction with bacteria in human periodontitis. *J Periodontol* 1982;53:752-761. PMID: 6961204 DOI: [10.1902/jop.1982.53.12.752](https://doi.org/10.1902/jop.1982.53.12.752)
7. Uitto V. Degradation of human gingiva, leukocytes and bacterial plaque. *J Periodontol* 1983;54:740-45. PMID: 6315910 DOI: [10.1902/jop.1983.54.12.740](https://doi.org/10.1902/jop.1983.54.12.740)
8. Dennision D, Van Dyke T. The acute inflammatory response and the role of phagocytic cells in periodontal health and disease. *Periodontol 2000* 1997;14:54-78. PMID: 9567966 DOI: [10.1111/j.1600-0757.1997.tb00192.x](https://doi.org/10.1111/j.1600-0757.1997.tb00192.x)
9. Cochran D. Inflammation and bone loss in periodontal disease. *J Periodontol* 2008;79: 1569-1576. PMID: 18673012 DOI: [10.1902/jop.2008.080233](https://doi.org/10.1902/jop.2008.080233)

Bacterial Invasion

10. Frank R, Vogel J. Bacterial bone resorption in advanced cases of human periodontitis. *J Periodontol Res.* 1978;13:251-61. PMID: 149195 DOI: [10.1111/j.1600-0765.1978.tb00177.x](https://doi.org/10.1111/j.1600-0765.1978.tb00177.x)
11. Saglie FR, et al. Identification of tissue invading bacteria in human periodontal disease. *J Periodontol Res.* 1982;17:452-455. PMID: 6218269 DOI: [10.1111/j.1600-0765.1982.tb02024.x](https://doi.org/10.1111/j.1600-0765.1982.tb02024.x)
12. Allenspach-Petrzilka G, Guggenheim B. Bacterial invasion of the periodontium: an important factor in the pathogenesis of periodontitis? *J Clin Periodontol.* 1983;10:609-617. PMID: 6581176 DOI: [10.1111/j.1600-051x.1983.tb01299.x](https://doi.org/10.1111/j.1600-051x.1983.tb01299.x)
13. Manor A, Lebendiger M, Shiffer A, Tove H. Bacterial invasion of periodontal tissues in advanced periodontitis in humans. *J Periodontol.* 1984;55:567-73. PMID: 6593450 DOI: [10.1902/jop.1984.55.10.567](https://doi.org/10.1902/jop.1984.55.10.567)
14. Gillett IR, Johnson NW, et al. The role of histopathology in the diagnosis and prognosis of periodontal diseases. *J Clin Periodontol.* 1990;17:673-84. PMID: 2262579 DOI: [10.1111/j.1600-051x.1990.tb01053.x](https://doi.org/10.1111/j.1600-051x.1990.tb01053.x)
15. Stashenko P, et al. Tissue levels of bone resorptive cytokines in periodontal disease. *J Periodontol.* 1991;62:504-509. PMID: 1920018 DOI: [10.1902/jop.1991.62.8.504](https://doi.org/10.1902/jop.1991.62.8.504)
16. Moskow B, Polson A. Histologic studies on the extension of the inflammatory infiltrate in human periodontitis. *J Clin Periodontol.* 1991;18:534-542. PMID: 1894748 DOI: [10.1111/j.1600-051x.1991.tb00086.x](https://doi.org/10.1111/j.1600-051x.1991.tb00086.x)

17. Schou S, Holmstrup P, Kornman K. Non-human primates used in studies of periodontal disease pathogenesis: a review of the literature. *J Periodontol*. 1993;64:497-508. PMID: 8336250 DOI: 10.1902/jop.1993.64.6.497
18. Contreras A, Slots J. Mammalian viruses in human periodontitis. *Oral Microbiol Immunol*. 1996;11:381-86. PMID: 9467370 DOI: 10.1111/j.1399-302x.1996.tb00199.x

Transmission

19. Greenstein G, Lamster I. Bacterial transmission in periodontal diseases: A critical review. *J Periodontol* 1997;68:421-31. PMID: 9182736 DOI: [10.1902/jop.1997.68.5.421](https://doi.org/10.1902/jop.1997.68.5.421)

2.4 Local factors

Furcation:

1. Hamp SE, Nyman S, Lindhe J. Periodontal treatment of multirooted teeth. Results after 5 years. *J Clin Periodontol*. 1975 Aug;2(3):126-35. doi: 10.1111/j.1600-051x.1975.tb01734.x. PMID: 1058213.
2. Tarnow D, Fletcher P. Classification of the vertical component of furcation involvement. *J Periodontol*. 1984 May;55(5):283-4. doi: 10.1902/jop.1984.55.5.283. PMID: 6588186.

Calculus:

3. Zander HA. The attachment of calculus to root surfaces. *J Periodontol*. 1953 Jan;24(1):16-19. <https://doi.org/10.1902/jop.1953.24.1.16>
4. Canis MF, Kramer GM, Pameijer CM. Calculus attachment. Review of the literature and new findings. *J Periodontol*. 1979 Aug;50(8):406-15. doi: 10.1902/jop.1979.50.8.406. PMID: 289756.
5. Fujikawa K, O'Leary TJ, Kafrawy AH. The effect of retained subgingival calculus on healing after flap surgery. *J Periodontol*. 1988 Mar;59(3):170-5. doi: 10.1902/jop.1988.59.3.170. PMID: 3283319.
6. Anerud A, Löe H, Boysen H. The natural history and clinical course of calculus formation in man. *J Clin Periodontol*. 1991 Mar;18(3):160-70. doi: 10.1111/j.1600-051x.1991.tb01128.x. PMID: 2061415.
7. Wilson TG, Harrel SK, Nunn ME, Francis B, Webb K. The relationship between the presence of tooth-borne subgingival deposits and inflammation found with a dental endoscope. *J Periodontol*. 2008 Nov;79(11):2029-35. doi: 10.1902/jop.2008.080189. PMID: 18980509.

Root proximity:

8. Tal H. Relationship between the interproximal distance of roots and the prevalence of intrabony pockets. *J Periodontol*. 1984 Oct;55(10):604-7. doi: 10.1902/jop.1984.55.10.604. PMID: 6593454.
9. Kim T, Miyamoto T, Nunn ME, Garcia RI, Dietrich T. Root proximity as a risk factor for progression of alveolar bone loss: the Veterans Affairs Dental Longitudinal Study. *J Periodontol*. 2008 Apr;79(4):654-9. doi: 10.1902/jop.2008.070477. PMID: 18380558.

Tooth-related factors/tooth anatomy:

10. Everett FG, Jump EB, Holder TD, Williams GC. The intermediate bifurcational ridge: a study of the morphology of the bifurcation of the lower first molar. *J Dent Res*. 1958 Feb;37(1):162-9. doi: 10.1177/00220345580370011001. PMID: 13513891.
11. Hou GL, Tsai CC. Cervical enamel projection and intermediate bifurcational ridge correlated with molar furcation involvements. *J Periodontol*. 1997 Jul;68(7):687-93. doi: 10.1902/jop.1997.68.7.687. PMID: 9249641.
12. Masters DH, Hoskins SW . Projection of cervical enamel into molar furcations. *J Periodontol*. 1964 35(1):49-53. doi: 10.1902/jop.1964.35.1.49
13. Hou GL, Tsai CC. Relationship between periodontal furcation involvement and molar cervical enamel projections. *J Periodontol*. 1987 Oct;58(10):715-21. doi: 10.1902/jop.1987.58.10.715. PMID: 3478466.
14. Moskow BS, Canut PM. Studies on root enamel (2). Enamel pearls. A review of their morphology, localization, nomenclature, occurrence, classification, histogenesis and incidence. *J Clin Periodontol*. 1990 May;17(5):275-81. doi: 10.1111/j.1600-051x.1990.tb01089.x. PMID: 2191975.

15. Withers JA, Brunsvold MA, Killoy WJ, Rahe AJ. The relationship of palato-gingival grooves to localized periodontal disease. *J Periodontol.* 1981 Jan;52(1):41-4. doi: 10.1902/jop.1981.52.1.41. PMID: 6937650.
16. Kogon SL. The prevalence, location and conformation of palato-radicular grooves in maxillary incisors. *J Periodontol.* 1986 Apr;57(4):231-4. doi: 10.1902/jop.1986.57.4.231. PMID: 3457145.
17. Hou GL, Tsai CC. Relationship between palato-radicular grooves and localized periodontitis. *J Clin Periodontol.* 1993 Oct;20(9):678-82. doi: 10.1111/j.1600-051x.1993.tb00715.x. PMID: 8227457.
18. Kepic TJ, O'Leary TJ. Role of marginal ridge relationships as an etiologic factor in periodontal disease. *J Periodontol.* 1978 Nov;49(11):570-5. doi: 10.1902/jop.1978.49.11.570. PMID: 281486.
19. Hancock EB, Mayo CV, Schwab RR, Wirthlin MR. Influence of interdental contacts on periodontal status. *J Periodontol.* 1980 Aug;51(8):445-9. doi: 10.1902/jop.1980.51.8.445. PMID: 6931204.
20. Jernberg GR, Bakdash MB, Keenan KM. Relationship between proximal tooth open contacts and periodontal disease. *J Periodontol.* 1983 Sep;54(9):529-33. doi: 10.1902/jop.1983.54.9.529. PMID: 6579279.
21. Kerns DG, Greenwell H, Wittwer JW, Drisko C, Williams JN, Kerns LL. Root trunk dimensions of 5 different tooth types. *Int J Periodontics Restorative Dent.* 1999 Feb;19(1):82-91. PMID: 10379289.
22. Ross IF, Evanchik PA. Root fusion in molars: incidence and sex linkage. *J Periodontol.* 1981 Nov;52(11):663-7. doi: 10.1902/jop.1981.52.11.663. PMID: 6946206.
23. Gutmann JL. Prevalence, location, and patency of accessory canals in the furcation region of permanent molars. *J Periodontol.* 1978 Jan;49(1):21-6. doi: 10.1902/jop.1978.49.1.21. PMID: 271710.
24. Adriaens PA, De Boever JA, Loesche WJ. Bacterial invasion in root cementum and radicular dentin of periodontally diseased teeth in humans. A reservoir of periodontopathic bacteria. *J Periodontol.* 1988 Apr;59(4):222-30. doi: 10.1902/jop.1988.59.4.222. PMID: 3164373.
25. Haney JM, Leknes KN, Lie T, Selvig KA, Wikesjö UM. Cemental tear related to rapid periodontal breakdown: a case report. *J Periodontol.* 1992 Mar;63(3):220-4. doi: 10.1902/jop.1992.63.3.220. PMID: 1593415.
26. Machtei EE, Hirsch I. Retention of hopeless teeth: the effect on the adjacent proximal bone following periodontal surgery. *J Periodontol.* 2007 Dec;78(12):2246-52. doi: 10.1902/jop.2007.070125. PMID: 18052695.
27. Kugelberg CF, Ahlström U, Ericson S, Hugoson A, Thilander H. The influence of anatomical, pathophysiological and other factors on periodontal healing after impacted lower third molar surgery. A multiple regression analysis. *J Clin Periodontol.* 1991 Jan;18(1):37-43. doi: 10.1111/j.1600-051x.1991.tb01117.x. PMID: 2045517.

Prosthesis-related factor:

28. Ingber JS, Rose LF, Coslet JG. The "biologic width"--a concept in periodontics and restorative dentistry. *Alpha Omegan.* 1977 Dec;70(3):62-5. PMID: 276259.
29. Jeffcoat MK, Howell TH. Alveolar bone destruction due to overhanging amalgam in periodontal disease. *J Periodontol.* 1980 Oct;51(10):599-602. doi: 10.1902/jop.1980.51.10.599. PMID: 6934287.
30. Wang HL, Burgett FG, Shyr Y. The relationship between restoration and furcation involvement on molar teeth. *J Periodontol.* 1993 Apr;64(4):302-5. doi: 10.1902/jop.1993.64.4.302. PMID: 8483093.

Reviews:

31. Kornman KS, Löe H. The role of local factors in the etiology of periodontal diseases. *Periodontol 2000.* 1993 Jun;2:83-97. doi: 10.1111/j.1600-0757.1993.tb00222.x. PMID: 9673183.
32. White DJ. Dental calculus: recent insights into occurrence, formation, prevention, removal and oral health effects of supragingival and subgingival deposits. *Eur J Oral Sci.* 1997 Oct;105(5 Pt 2):508-22. doi: 10.1111/j.1600-0722.1997.tb00238.x. PMID: 9395117.
33. Matthews DC, Tabesh M. Detection of localized tooth-related factors that predispose to periodontal infections. *Periodontol 2000.* 2004;34:136-50. doi: 10.1046/j.0906-6713.2003.003429.x. PMID: 14717860.

2.5 Environmental factors/habits

Smoking:

1. Preber H, Bergström J. Effect of cigarette smoking on periodontal healing following surgical therapy. *J Clin Periodontol.* 1990 May;17(5):324-8. doi: 10.1111/j.1600-051x.1990.tb01098.x. PMID: 2355098.
2. Bergström J, Eliasson S, Preber H. Cigarette smoking and periodontal bone loss. *J Periodontol.* 1991 Apr;62(4):242-6. doi: 10.1902/jop.1991.62.4.242. PMID: 2037954.
2. MacFarlane GD, Herzberg MC, Wolff LF, Hardie NA. Refractory periodontitis associated with abnormal polymorphonuclear leukocyte phagocytosis and cigarette smoking. *J Periodontol.* 1992 Nov;63(11):908-13. doi: 10.1902/jop.1992.63.11.908. PMID: 1333526.
3. Haber J, Wattles J, Crowley M, Mandell R, Joshipura K, Kent RL. Evidence for cigarette smoking as a major risk factor for periodontitis. *J Periodontol.* 1993 Jan;64(1):16-23. doi: 10.1902/jop.1993.64.1.16. PMID: 8426285.
4. Ah MK, Johnson GK, Kaldahl WB, Patil KD, Kalkwarf KL. The effect of smoking on the response to periodontal therapy. *J Clin Periodontol.* 1994 Feb;21(2):91-7. doi: 10.1111/j.1600-051x.1994.tb00285.x. PMID: 8144739.
5. Tonetti MS, Pini-Prato G, Cortellini P. Effect of cigarette smoking on periodontal healing following GTR in infrabony defects. A preliminary retrospective study. *J Clin Periodontol.* 1995 Mar;22(3):229-34. doi: 10.1111/j.1600-051x.1995.tb00139.x. PMID: 7790529.
6. Tonetti MS. Cigarette smoking and periodontal diseases: etiology and management of disease. *Ann Periodontol.* 1998 Jul;3(1):88-101. doi: 10.1902/annals.1998.3.1.88. PMID: 9722693.
7. Bergström J, Eliasson S, Dock J. A 10-year prospective study of tobacco smoking and periodontal health. *J Periodontol.* 2000 Aug;71(8):1338-47. doi: 10.1902/jop.2000.71.8.1338. PMID: 10972650.
8. Tomar SL, Asma S. Smoking-Attributable Periodontitis in the United States: Findings From NHANES III. *J Periodontol.* 2000 May;71(5):743-751. doi: 10.1902/jop.2000.71.5.743. PMID: 29537517.
9. Javed F, Al-Kheraif AA, Rahman I, Millan-Luongo LT, Feng C, Yunker M, Malmstrom H, Romanos GE. Comparison of Clinical and Radiographic Periodontal Status Between Habitual Water-Pipe Smokers and Cigarette Smokers. *J Periodontol.* 2016 Feb;87(2):142-7. doi: 10.1902/jop.2015.150235. PMID: 26430928.

Stress and others:

10. Shields WD. Acute necrotizing ulcerative gingivitis. A study of some of the contributing factors and their validity in an Army population. *J Periodontol.* 1977 Jun;48(6):346-9. doi: 10.1902/jop.1977.48.6.346. PMID: 266582.
11. Deinzer R, Förster P, Fuck L, Herforth A, Stiller-Winkler R, Idel H. Increase of crevicular interleukin 1beta under academic stress at experimental gingivitis sites and at sites of perfect oral hygiene. *J Clin Periodontol.* 1999 Jan;26(1):1-8. doi: 10.1034/j.1600-051x.1999.260101.x. PMID: 9923503.
12. Genco RJ, Ho AW, Grossi SG, Dunford RG, Tedesco LA. Relationship of stress, distress and inadequate coping behaviors to periodontal disease. *J Periodontol.* 1999 Jul;70(7):711-23. doi: 10.1902/jop.1999.70.7.711. PMID: 10440631.
13. Campbell A, Moore A, Williams E, Stephens J, Tatakis DN. Tongue piercing: impact of time and barbell stem length on lingual gingival recession and tooth chipping. *J Periodontol.* 2002 Mar;73(3):289-97. doi: 10.1902/jop.2002.73.3.289. PMID: 11922258.
14. Tezal M, Grossi SG, Ho AW, Genco RJ. Alcohol consumption and periodontal disease. The Third National Health and Nutrition Examination Survey. *J Clin Periodontol.* 2004 Jul;31(7):484-8. doi: 10.1111/j.1600-051X.2004.00503.x. PMID: 15191580.

Reviews:

15. Johnson GK, Hill M. Cigarette smoking and the periodontal patient. *J Periodontol.* 2004 Feb;75(2):196-209. doi: 10.1902/jop.2004.75.2.196. PMID: 15068107.

16. Palmer RM, Wilson RF, Hasan AS, Scott DA. Mechanisms of action of environmental factors--tobacco smoking. *J Clin Periodontol.* 2005;32 Suppl 6:180-95. doi: 10.1111/j.1600-051X.2005.00786.x. PMID: 16128837.
17. Fiorini T, Musskopf ML, Oppermann RV, Susin C. Is there a positive effect of smoking cessation on periodontal health? A systematic review. *J Periodontol.* 2014 Jan;85(1):83-91. doi: 10.1902/jop.2013.130047. PMID: 23600995.
18. Peruzzo DC, Benatti BB, Ambrosano GM, Nogueira-Filho GR, Sallum EA, Casati MZ, Nociti FH Jr. A systematic review of stress and psychological factors as possible risk factors for periodontal disease. *J Periodontol.* 2007 Aug;78(8):1491-504. doi: 10.1902/jop.2007.060371. PMID: 17668968.
19. Yazdanian M, Armoor B, Noroozi A, Mohammadi R, Bayat AH, Ahounbar E, Higgs P, Nasab HS, Bayani A, Hemmat M. Dental caries and periodontal disease among people who use drugs: a systematic review and meta-analysis. *BMC Oral Health.* 2020 Feb 10;20(1):44. doi: 10.1186/s12903-020-1010-3. PMID: 32041585; PMCID: PMC7011515.

2.6 Systemic factors

Diabetes Mellitus:

1. Manouchehr-Pour M, Spagnuolo PJ, Rodman HM, Bissada NF. Comparison of neutrophil chemotactic response in diabetic patients with mild and severe periodontal disease. *J Periodontol.* 1981 Aug;52(8):410-5. doi: 10.1902/jop.1981.52.8.410. PMID: 7021793.
2. Nelson RG, Shlossman M, Budding LM, Pettitt DJ, Saad MF, Genco RJ, Knowler WC. Periodontal disease and NIDDM in Pima Indians. *Diabetes Care.* 1990 Aug;13(8):836-40. doi: 10.2337/diacare.13.8.836. PMID: 2209317.
3. Emrich LJ, Shlossman M, Genco RJ. Periodontal disease in non-insulin-dependent diabetes mellitus. *J Periodontol.* 1991 Feb;62(2):123-31. doi: 10.1902/jop.1991.62.2.123. PMID: 2027060.
4. Seppälä B, Seppälä M, Ainamo J. A longitudinal study on insulin-dependent diabetes mellitus and periodontal disease. *J Clin Periodontol.* 1993 Mar;20(3):161-5. doi: 10.1111/j.1600-051x.1993.tb00338.x. PMID: 8450080.
5. Löe H. Periodontal disease. The sixth complication of diabetes mellitus. *Diabetes Care.* 1993 Jan;16(1):329-34. PMID: 8422804.
6. Westfelt E, Rylander H, Blohmé G, Jonasson P, Lindhe J. The effect of periodontal therapy in diabetics. Results after 5 years. *J Clin Periodontol.* 1996 Feb;23(2):92-100. doi: 10.1111/j.1600-051x.1996.tb00540.x. PMID: 8849844.
7. Lalla E, Cheng B, Lal S, Kaplan S, Softness B, Greenberg E, Goland RS, Lamster IB. Diabetes mellitus promotes periodontal destruction in children. *J Clin Periodontol.* 2007 Apr;34(4):294-8. doi: 10.1111/j.1600-051X.2007.01054.x. PMID: 17378885.
8. Costa FO, Miranda Cota LO, Pereira Lages EJ, Soares Dutra Oliveira AM, Dutra Oliveira PA, Cyrino RM, Medeiros Lorentz TC, Cortelli SC, Cortelli JR. Progression of periodontitis and tooth loss associated with glycemic control in individuals undergoing periodontal maintenance therapy: a 5-year follow-up study. *J Periodontol.* 2013 May;84(5):595-605. doi: 10.1902/jop.2012.120255. Epub 2012 Jul 6. PMID: 22769441.
9. Garcia D, Tarima S, Okunseri C. Periodontitis and glycemic control in diabetes: NHANES 2009 to 2012. *J Periodontol.* 2015 Apr;86(4):499-506. doi: 10.1902/jop.2014.140364. Epub 2014 Nov 27. PMID: 25427615.
10. D'Aiuto F, Gkranias N, Bhowruth D, Khan T, Orlandi M, Suvan J, Masi S, Tsakos G, Hurel S, Hingorani AD, Donos N, Deanfield JE; TASTE Group. Systemic effects of periodontitis treatment in patients with type 2 diabetes: a 12 month, single-centre, investigator-masked, randomised trial. *Lancet Diabetes Endocrinol.* 2018 Dec;6(12):954-965. doi: 10.1016/S2213-8587(18)30038-X. Epub 2018 Oct 24. Erratum in: *Lancet Diabetes Endocrinol.* 2019 Mar;7(3):e3. PMID: 30472992.

Obesity:

11. Haffajee AD, Socransky SS. Relation of body mass index, periodontitis and Tannerella forsythia. *J Clin Periodontol.* 2009 Feb;36(2):89-99. doi: 10.1111/j.1600-051X.2008.01356.x. PMID: 19207883. 19

12. Cutler CW, Shinedling EA, Nunn M, Jotwani R, Kim BO, Nares S, Iacopino AM. Association between periodontitis and hyperlipidemia: cause or effect? *J Periodontol.* 1999 Dec;70(12):1429-34. doi: 10.1902/jop.1999.70.12.1429. PMID: 10632517.

Pregnancy/Hormone:

13. Offenbacher S, Lieff S, Boggess KA, Murtha AP, Madianos PN, Champagne CM, McKaig RG, Jared HL, Mauriello SM, Auten RL Jr, Herbert WN, Beck JD. Maternal periodontitis and prematurity. Part I: Obstetric outcome of prematurity and growth restriction. *Ann Periodontol.* 2001 Dec;6(1):164-74. doi: 10.1902/annals.2001.6.1.164. PMID: 11887460.
14. Jeffcoat MK, Geurs NC, Reddy MS, Cliver SP, Goldenberg RL, Hauth JC. Periodontal infection and preterm birth: results of a prospective study. *J Am Dent Assoc.* 2001 Jul;132(7):875-80. doi: 10.14219/jada.archive.2001.0299. PMID: 11480640.

Medications:

15. Pihlstrom BL, Carlson JF, Smith QT, Bastien SA, Keenan KM. Prevention of phenytoin associated gingival enlargement--a 15-month longitudinal study. *J Periodontol.* 1980 Jun;51(6):311-7. doi: 10.1902/jop.1980.51.6.311. PMID: 6930469.
16. Pernu HE, Pernu LM, Huttunen KR, Nieminen PA, Knuutila ML. Gingival overgrowth among renal transplant recipients related to immunosuppressive medication and possible local background factors. *J Periodontol.* 1992 Jun;63(6):548-53. doi: 10.1902/jop.1992.63.6.548. PMID: 1625155.
17. Ellis JS, Seymour RA, Steele JG, Robertson P, Butler TJ, Thomason JM. Prevalence of gingival overgrowth induced by calcium channel blockers: a community-based study. *J Periodontol.* 1999 Jan;70(1):63-7. doi: 10.1902/jop.1999.70.1.63. PMID: 10052772.
18. de Oliveira Costa F, Diniz Ferreira S, de Miranda Cota LO, da Costa JE, Aguiar MA. Prevalence, severity, and risk variables associated with gingival overgrowth in renal transplant subjects treated under tacrolimus or cyclosporin regimens. *J Periodontol.* 2006 Jun;77(6):969-75. doi: 10.1902/jop.2006.050327. PMID: 16734570.
19. Güncü GN, Caglayan F, Dinçel A, Bozkurt A, Saygi S, Karabulut E. Plasma and gingival crevicular fluid phenytoin concentrations as risk factors for gingival overgrowth. *J Periodontol.* 2006 Dec;77(12):2005-10. doi: 10.1902/jop.2006.060103. PMID: 17209785.

CVD/Renal diseases/Rheumatoid arthritis/Osteoporosis:

20. Reinhardt RA, Payne JB, Maze CA, Patil KD, Gallagher SJ, Mattson JS. Influence of estrogen and osteopenia/osteoporosis on clinical periodontitis in postmenopausal women. *J Periodontol.* 1999 Aug;70(8):823-8. doi: 10.1902/jop.1999.70.8.823. PMID: 10476887.
21. Xu F, Lu B. Prospective association of periodontal disease with cardiovascular and all-cause mortality: NHANES III follow-up study. *Atherosclerosis.* 2011 Oct;218(2):536-42. doi: 10.1016/j.atherosclerosis.2011.07.091. Epub 2011 Jul 23. PMID: 21831372.
22. Yoshihara A, Iwasaki M, Miyazaki H, Nakamura K. Bidirectional relationship between renal function and periodontal disease in older Japanese women. *J Clin Periodontol.* 2016 Sep;43(9):720-6. doi: 10.1111/jcpe.12576. Epub 2016 Jul 18. PMID: 27168164.
23. Rodríguez-Lozano B, González-Febles J, Garnier-Rodríguez JL, Dadlani S, Bustabad-Reyes S, Sanz M, Sánchez-Alonso F, Sánchez-Piedra C, González-Dávila E, Díaz-González F. Association between severity of periodontitis and clinical activity in rheumatoid arthritis patients: a case-control study. *Arthritis Res Ther.* 2019 Jan 18;21(1):27. doi: 10.1186/s13075-019-1808-z. PMID: 30658685; PMCID: PMC6339403.

Aging:

24. Grant D, Bernick S. The periodontium of ageing humans. *J Periodontol.* 1972 Nov;43(11):660-7. doi: 10.1902/jop.1972.43.11.660. PMID: 4508345.
25. Lindhe J, Socransky S, Nyman S, Westfelt E, Haffajee A. Effect of age on healing following periodontal therapy. *J Clin Periodontol.* 1985 Oct;12(9):774-87. doi: 10.1111/j.1600-051x.1985.tb01403.x. PMID: 3863846.

Overall:

26. Genco RJ, Borgnakke WS. Risk factors for periodontal disease. *Periodontol 2000*. 2013 Jun;62(1):59-94. doi: 10.1111/j.1600-0757.2012.00457.x. PMID: 23574464.

Diabetes Mellitus:

27. Mealey BL, Oates TW; American Academy of Periodontology. Diabetes mellitus and periodontal diseases. *J Periodontol*. 2006 Aug;77(8):1289-303. doi: 10.1902/jop.2006.050459. PMID: 16881798.
28. Lalla E, Papapanou PN. Diabetes mellitus and periodontitis: a tale of two common interrelated diseases. *Nat Rev Endocrinol*. 2011 Jun 28;7(12):738-48. doi: 10.1038/nrendo.2011.106. PMID: 21709707.
29. Engebretson S, Kocher T. Evidence that periodontal treatment improves diabetes outcomes: a systematic review and meta-analysis. *J Periodontol*. 2013 Apr;84(4 Suppl):S153-69. doi: 10.1902/jop.2013.1340017. PMID: 23631575; PMCID: PMC4100543.

Obesity/Nutrition:

30. Nibali L, Tatarakis N, Needleman I, Tu YK, D'Aiuto F, Rizzo M, Donos N. Clinical review: Association between metabolic syndrome and periodontitis: a systematic review and meta-analysis. *J Clin Endocrinol Metab*. 2013 Mar;98(3):913-20. doi: 10.1210/jc.2012-3552. Epub 2013 Feb 5. PMID: 23386648.
31. Schifferle RE. Periodontal disease and nutrition: separating the evidence from current fads. *Periodontol 2000*. 2009;50:78-89. doi: 10.1111/j.1600-0757.2008.00297.x. PMID: 19388955.

Pregnancy/Hormone:

32. Madianos PN, Bobetsis YA, Offenbacher S. Adverse pregnancy outcomes (APOs) and periodontal disease: pathogenic mechanisms. *J Periodontol*. 2013 Apr;84(4 Suppl):S170-80. doi: 10.1902/jop.2013.1340015. PMID: 23631577.
33. Polyzos NP, Polyzos IP, Zavos A, Valachis A, Mauri D, Papanikolaou EG, Tzioras S, Weber D, Messinis IE. Obstetric outcomes after treatment of periodontal disease during pregnancy: systematic review and meta-analysis. *BMJ*. 2010 Dec 29;341:c7017. doi: 10.1136/bmj.c7017. PMID: 21190966; PMCID: PMC3011371.

Medications:

34. Dongari-Bagtzoglou A; Research, Science and Therapy Committee, American Academy of Periodontology. Drug-associated gingival enlargement. *J Periodontol*. 2004 Oct;75(10):1424-31. doi: 10.1902/jop.2004.75.10.1424. PMID: 15562922.

CVD/Renal diseases/Rheumatoid arthritis/Osteoporosis:

35. Lockhart PB, Bolger AF, Papapanou PN, Osinbowale O, Trevisan M, Levison ME, Taubert KA, Newburger JW, Gornik HL, Gewitz MH, Wilson WR, Smith SC Jr, Baddour LM; American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee of the Council on Cardiovascular Disease in the Young, Council on Epidemiology and Prevention, Council on Peripheral Vascular Disease, and Council on Clinical Cardiology. Periodontal disease and atherosclerotic vascular disease: does the evidence support an independent association?: a scientific statement from the American Heart Association. *Circulation*. 2012 May 22;125(20):2520-44. doi: 10.1161/CIR.0b013e31825719f3. Epub 2012 Apr 18. PMID: 22514251.
36. Schenkein HA, Loos BG. Inflammatory mechanisms linking periodontal diseases to cardiovascular diseases. *J Periodontol*. 2013 Apr;84(4 Suppl):S51-69. doi: 10.1902/jop.2013.134006. PMID: 23631584.
37. Payne JB, Golub LM, Thiele GM, Mikuls TR. The Link Between Periodontitis and Rheumatoid Arthritis: A Periodontist's Perspective. *Curr Oral Health Rep*. 2015;2(1):20-29. doi: 10.1007/s40496-014-0040-9. PMID: 25657894; PMCID: PMC4312393.
38. Wang CJ, McCauley LK. Osteoporosis and Periodontitis. *Curr Osteoporos Rep*. 2016 Dec;14(6):284-291. doi: 10.1007/s11914-016-0330-3. PMID: 27696284; PMCID: PMC5654540.

2.7 Genetics and epigenetics

1. Michalowicz BS, Aeppli D, Virag JG, et al. Periodontal findings in adult twins. *J Periodontol*. 1991;62:293-299.

2. Kornman KS, Crane A, Wang HY, et al. The interleukin-1 genotype as a severity factor in adult periodontal disease. *J Clin Periodontol.* 1997;24:72-77.
3. McGuire MK, Nunn ME. Prognosis versus actual outcome. IV. The effectiveness of clinical parameters and IL-1 genotype in accurately predicting prognoses and tooth survival. *J Periodontol.* 1999;70:49-56.
4. Michalowicz BS, Diehl SR, Gunsolley JC, et al. Evidence of a substantial genetic basis for risk of adult periodontitis. *J Periodontol.* 2000;71:1699-1707.
5. Socransky SS, Haffajee AD, Smith C, Duff GW. Microbiological parameters associated with IL-1 gene polymorphisms in periodontitis patients. *J Clin Periodontol.* 2000;27:810-818.
6. Kobayashi T, Ito S, Kuroda T, et al. The interleukin-1 and Fcgamma receptor gene polymorphisms in Japanese patients with rheumatoid arthritis and periodontitis. *J Periodontol.* 2007;78:2311-2318.
7. Haubek D, Ennibi OK, Poulsen K, Vaeth M, Poulsen S, Kilian M. Risk of aggressive periodontitis in adolescent carriers of the JP2 clone of Aggregatibacter (Actinobacillus) actinomycetemcomitans in Morocco: a prospective longitudinal cohort study. *Lancet.* 2008;371:237-242.
8. Ishida K, Kobayashi T, Ito S, et al. Interleukin-6 gene promoter methylation in rheumatoid arthritis and chronic periodontitis. *J Periodontol.* 2012;83:917-925.
9. Kobayashi T, Ishida K, Yoshie H. Increased expression of interleukin-6 (IL-6) gene transcript in relation to IL-6 promoter hypomethylation in gingival tissue from patients with chronic periodontitis. *Arch Oral Biol.* 2016;69:89-94.
10. Shaddox LM, Mullersman AF, Huang H, Wallet SM, Langae T, Aukhil I. Epigenetic regulation of inflammation in localized aggressive periodontitis. *Clin Epigenetics.* 2017;9:94.

Reviews:

11. da Silva MK, de Carvalho ACG, Alves EHP, da Silva FRP, Pessoa LDS, Vasconcelos DFP. Genetic Factors and the Risk of Periodontitis Development: Findings from a Systematic Review Composed of 13 Studies of Meta-Analysis with 71,531 Participants. *Int J Dent.* 2017;2017:1914073.
12. Larsson L, Castilho RM, Giannobile WV. Epigenetics and its role in periodontal diseases: a state-of-the-art review. *J Periodontol.* 2015;86:556-568.

2.8 Immune response: humoral and cellular

1. Mackler BF, Waldrop TC, Schur P, Robertson PB, Levy BM. IgG subclasses in human periodontal disease. I. Distribution and incidence of IgG subclass bearing lymphocytes and plasma cells. *J Periodontal Res.* 1978;13:109-119.
2. Bissada NF, Manouchehr-Pour M, Haddow M, Spagnuolo PJ. Neutrophil functional activity in juvenile and adult onset diabetic patients with mild and severe periodontitis. *J Periodontal Res.* 1982;17:500-502.
3. Offenbacher S, Odle BM, Gray RC, Van Dyke TE. Crevicular fluid prostaglandin E levels as a measure of the periodontal disease status of adult and juvenile periodontitis patients. *J Periodontal Res.* 1984;19:1-13.
4. Reinhardt RA, Bolton RW, McDonald TL, DuBois LM, Kaldahl WB. In situ lymphocyte subpopulations from active versus stable periodontal sites. *J Periodontol.* 1988;59:656-670.
5. Reinhardt RA, McDonald TL, Bolton RW, DuBois LM, Kaldahl WB. IgG subclasses in gingival crevicular fluid from active versus stable periodontal sites. *J Periodontol.* 1989;60:44-50.

6. Van Dyke TE, Warbington M, Gardner M, Offenbacher S. Neutrophil surface protein markers as indicators of defective chemotaxis in LJP. *J Periodontol*. 1990;61:180-184.
7. Schenkein HA, Best AM, Gunsolley JC. Influence of race and periodontal clinical status on neutrophil chemotactic responses. *J Periodontal Res*. 1991;26:272-275.
8. Ebersole JL, Brunsvold M, Steffensen B, Wood R, Holt SC. Effects of immunization with *Porphyromonas gingivalis* and *Prevotella intermedia* on progression of ligature-induced periodontitis in the nonhuman primate *Macaca fascicularis*. *Infect Immun*. 1991;59:3351-3359.
9. Grbic JT, Singer RE, Jans HH, Celenti RS, Lamster IB. Immunoglobulin isotypes in gingival crevicular fluid: possible protective role of IgA. *J Periodontol*. 1995;66:55-61.
10. Johnson RB, Wood N, Serio FG. Interleukin-11 and IL-17 and the pathogenesis of periodontal disease. *J Periodontol*. 2004;75:37-43.

Reviews:

1. Genco RJ. Host responses in periodontal diseases: current concepts. *J Periodontol*. 1992;63:338-355.
2. Ebersole JL, Taubman MA. The protective nature of host responses in periodontal diseases. *Periodontol 2000*. 1994;5:112-141.
3. Gemmell E, Seymour GJ. Immunoregulatory control of Th1/Th2 cytokine profiles in periodontal disease. *Periodontol 2000*. 2004;35:21-41.
4. Garlet GP. Destructive and protective roles of cytokines in periodontitis: a re-appraisal from host defense and tissue destruction viewpoints. *J Dent Res*. 2010;89:1349-1363.
5. Van Dyke TE, van Winkelhoff AJ. Infection and inflammatory mechanisms. *J Periodontol*. 2013;84:S1-7.

3. Examination, disease activity, and diagnostic tools

3.1 Probing, mobility, bleeding on probing

Questions to be answered in this section:

- What are the different causes for probing depth errors?
- What are different types of periodontal probes?
- How is bleeding on probing (BOP) as an indicator of periodontal disease?
- What is the effect of tooth mobility on disease progression?

Periodontal probing

Terminology:

1. Listgarten MA. Periodontal terminology. *J Periodontol* 1993;64:918. PMID: 8229631

Angulation and position:

2. Persson G. Effects of line-angle versus midproximal periodontal probing measurements on prevalence estimates of periodontal disease. *J Periodont Res* 1991;26:527-529. PMID: 1837057 DOI: 10.1111/j.1600-0765.1991.tb01805.x

Probing force:

3. Listgarten MA, Mao R, Robinson PJ. Periodontal probing and the relationship of the probe tip to periodontal tissues. *J Periodontol* 1976;47:511-513. PMID: 1067404 DOI: 10.1902/jop.1976.47.9.511

4. Armitage GC, Svanberg GK, Loe H. Microscopic evaluation of clinical measurements of connective tissue attachment level. *J Clin Periodontol* 1977;4:173-190. PMID: 268333 DOI: 10.1111/j.1600-051x.1977.tb02271.x
5. Freed HK, Gapper RL, Kalkwarf KL. Evaluation of periodontal probing forces. *J Periodontol* 1983;54:488-492. PMID: 6578320 DOI: 10.1902/jop.1983.54.8.488
6. Mombelli A, Muhle T, Frigg R. Depth-force patterns of periodontal probing. *J Clin Periodontol* 1992;19:295-300. PMID: 1517472 DOI: 10.1111/j.1600-051x.1992.tb00647.x
7. Larsen C, Barendregt DS, Slot DE, Van der Velden U, Van der Weijden F. Probing pressure, a highly undervalued unit of measure in periodontal probing: a systematic review on its effect on probing pocket depth. *J Clin Periodontol* 2009;36(4):315-22. PMID: 19426178 DOI: 10.1111/j.1600-051X.2009.01383.x

Effect of inflammation:

8. Robinson PJ, Vitek RM. The relationship between gingival inflammation and resistance to probe penetration. *J Periodont Res* 1979;14:239-243. PMID: 158084 DOI: 10.1111/j.1600-0765.1979.tb00229.x
9. Fowler CT, Garrett S, Crigger M, Egelberg J. Histological probe position in treated and untreated human periodontal tissues. *J Clin Periodontol* 1982;9:373-385. PMID: 6754765 DOI: 10.1111/j.1600-051x.1982.tb02048.x
10. Badersten A, Nilveus R, Egelberg J. Reproducibility of probing attachment level measurements. *J Clin Periodontol* 1984;11:475-85. PMID: 6589244 DOI: 10.1111/j.1600-051x.1984.tb01347.x

Types of probes:

11. Pihlstrom BL. Measurement of attachment level in clinical trials: probing methods. *J Periodontol* 1992;63:1072-1077. PMID: 1479528 DOI: 10.1902/jop.1992.63.12s.1072
12. Grossi SG, Dunford RG, Ho A, Koch G, Machtei EE, Genco RJ. Sources of error for periodontal probing measurements. *J Periodontal Res* 1996;31:330-6. PMID: 8858537 DOI: 10.1111/j.1600-0765.1996.tb00500.x

Tooth mobility:

Classification and measurement of mobility:

1. Miller SC, *Textbook of Periodontia*, 1950, Blackston: Philadelphia. p. 125
2. Yankell SL. Review of methods for measuring tooth mobility. *Compendium* 1988;(l2) Suppl:S428-32. PMID: 3078270
3. Weatherford T. Tooth mobility: mechanisms and treatment. *Ala J Med Sci* 1977;14:32-38. PMID: 848692
4. Anderegg CR, Metzler DG. Tooth mobility revisited. *J Periodontol* 2001;72(7):963-967 PMID: 11495147 DOI: 10.1902/jop.2001.72.7.963

Tooth mobility and diagnosis/prognosis/therapy:

5. Greenstein G, Polson A. Understanding tooth mobility. *Compendium* 1988 Jun;9(6):470-1, 473-9. PMID: 3073858
6. Giargia M, Lindhe J. Tooth mobility and periodontal disease. *J Clin Periodontol* 1997;24:785-95 PMID: 9402498 DOI: 10.1111/j.1600-051x.1997.tb01190.x

Bleeding on probing:

1. Lang NP, Adler R, Joss A, Nyman S. Absence of bleeding on probing. An indicator of periodontal stability. *J Clin Periodontol.* 1990 Nov;17(10):714-21. doi: 10.1111/j.1600-051x.1990.tb01059.x. PMID: 2262585.
2. Lang NP, Joss A, Tonetti MS. Monitoring disease during supportive periodontal treatment by

- bleeding on probing. *Periodontol 2000* 1996; 12:44-8. PMID: 9567993 DOI: 10.1111/j.1600-0757.1996.tb00080.x
3. Armitage GC. Periodontal diseases: diagnosis. *Ann Periodontol* 1996;1:37-215. Pages 46-53 PMID: 9118264 DOI: 10.1902/annals.1996.1.1.37

3.2 Indices

Questions to be answered in this session:

- What are the different types of plaque, gingival and bleeding indices used during complete periodontal examination?
- What is the relevance of periodontal indices in periodontal disease diagnosis and progression?

Periodontal indices

Plaque indices:

1. Silness J, Löe H. Periodontal disease in pregnancy II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand* 1964;22:121-135. PMID: 14158464 DOI: 10.3109/00016356408993968
2. Turesky S, Gilmore N, Glickman I. Reduced plaque formation by the chloromethyl analogue of vitamin C. *J Periodontol* 1970;41 :41-43. PMID: 5264376 DOI: 10.1902/jop.1970.41.41.41

Gingival indices:

1. Löe H, Silness J. Periodontal disease in pregnancy I. Prevalence and severity. *Acta Odontol Scand* 1963;21:533-551. PMID: 14121956 DOI: 10.3109/00016356309011240
2. Lobene RR, Weatherford T, Ross NM, Lamm RA, Menaker L. A modified gingival index for use in clinical trials. *Clinical Preventive Dentistry* 1986;8:3-6. PMID: 3485495

Bleeding indices:

3. Newbrun E. Indices to measure gingival bleeding. *J Periodontol* 1996;67:555-561. PMID: 8794964 DOI: 10.1902/jop.1996.67.6.555

CPITN:

4. Ainamo J, Barnes D, Beagrie G, Cutress T, Martin J, Sardo-Infirri J. Development of the World Health Organisation (WHO) community periodontal index of treatment needs (CPITN). *Int Dent J* 1982;32:281-292. PMID: 6958657
5. Almas K, Bulman J, Newman H. Assessment of periodontal status with CPITN and conventional periodontal indices. *J Clin Periodontol* 1991;18:654-659. PMID: 1960234 DOI: 10.1111/j.1600-051x.1991.tb00106.x

Relevance of indices to clinical practice:

6. Barnes G, Parker W, Lyon T, Fultz R. Indices used to evaluate signs, symptoms and etiologic factors associated with diseases of the periodontium. *J Periodontol* 1986;57:643-651. PMID: 3464735 DOI: 10.1902/jop.1986.57.10.643
7. Chaves E, Wood R, Jones A, Newbold D, Manwell M, Komman K. Relationship of "bleeding on probing" and "gingival index bleeding" as clinical parameters of gingival inflammation. *J Clin Periodontol* 1993;20:139-143. PMID: 8436633 DOI: 10.1111/j.1600-051x.1993.tb00328.x

3.3 Host Biomarkers

Questions to be answered in this session:

- Is GCF a reliable marker of gingival health?
- What are varying diagnostic biomarkers present in GCF?
- How can components of saliva be used in assessment of disease status?

Gingival crevicular fluid:

1. Orban JE, Stallard RE. Gingival crevicular fluid: A reliable predictor of gingival health? *J Periodontol.* 1969;40:231-235. PMID: 5253991 DOI: 10.1902/jop.1969.40.4.231
2. Hancock EB, et al. The relationship between gingival crevicular fluid and gingival inflammation - A clinical and histologic study. *J Periodontol.* 1979;50:13-19. PMID: 368310 DOI: 10.1902/jop.1979.50.1.13
3. Lamster I, Grbic T. Diagnosis of periodontal disease based on analysis of the host response. *Periodontology 2000.* 1995;7:83-99. PMID: 9567932 DOI: 10.1111/j.1600-0757.1995.tb00038.x
4. Armitage GC. Periodontal diseases: diagnosis. *Ann Periodontol.* 1996;1:37-215. Pages 97-169 PMID: 9118264 DOI: 10.1902/annals.1996.1.1.37
5. Chapple ILC. Periodontal disease diagnosis: current status and future developments. *J Dent.* 1997;25:3-15. PMID: 9080734 DOI: 10.1016/s0300-5712(95)00118-2
6. Griffiths GS. Formation, collection and significance of gingival crevice fluid. *Periodontol 2000.* 2003;31:32-42. PMID: 12656994 DOI: 10.1034/j.1600-0757.2003.03103.x
7. Loos BG, Tjoa S. Host-derived diagnostic markers for periodontitis: do they exist in gingival crevice fluid? *Periodontol 2000.* 2005;39:53-72. PMID: 16135064 DOI: 10.1111/j.1600-0757.2005.00129.x
8. Reinhardt R, Stoner J, et al. Association of GCF biomarkers during periodontal maintenance with subsequent progressive periodontitis. *J Periodontol.* 2010;81:251-259. PMID: 20151804 DOI: 10.1902/jop.2009.090374

Saliva:

Zhang L, Henson BS, Camargo PM, Wong DT. The clinical value of salivary biomarkers for periodontal disease. *Periodontol 2000.* 2009;51:25-37. doi: 10.1111/j.1600-0757.2009.00315.x. PMID: 19878467.

3.4 Radiology

Questions to be answered in this session:

- What is the normal radiographic appearance of periodontal structures?
- What is the association between radiographic bone loss and disease progression?
- How is the accuracy of different types of radiographs in predicting bone loss?

Limitations and usefulness of radiographs:

1. Prichard J. Interpretation of radiographs in periodontics. *Int J Periodontics Restorative Dent* 1983;3:8-39. PMID: 6574120
2. Manson JD. The lamina dura. *Oral Medicine, Oral Surgery and Oral Pathology* 1963;16:432-438.
3. Greenstein G, Polson A, Iker H, Meitner S. Associations between crestal lamina dura and periodontal status. *J Periodontol* 1981;52:362-366. PMID: 6942152 DOI: 10.1902/jop.1981.52.7.362
4. Hausmann E, Allen K, Clerehugh V. What alveolar crest level on a bite-wing radiograph represents bone loss? *J Periodontol* 1991;62:570-2. PMID: 1941497 DOI: 10.1902/jop.1991.62.9.570

5. Rams TE, Listgarten MA, Slots J. Utility of radiographic crestal lamina dura for predicting periodontitis disease-activity. *J Clin Periodontol* 1994;21 :571-6. PMID: 7806671 DOI: 10.1111/j.1600-051x.1994.tb00745.x

Radiographs in relation to clinical parameters - Comparison of conventional radiographic techniques:

6. Buchanan S, Jenderseck R, Granet M, Kircos L, Chambers D, Robertson P. Radiographic detection of dental calculus. *J Periodontol* 1987;58:747-751. PMID: 3480347 DOI: 10.1902/jop.1987.58.11.747
7. Akesson L, Hakansson J, Rohlin M. Comparison of panoramic and intraoral radiography and pocket probing for the measurement of the marginal bone level. *J Clin Periodontol* 1992;19:326-32. PMID: 1517478 DOI: 10.1111/j.1600-051x.1992.tb00654.x
8. Machtei EE, Hausmann E, Grossi SG, Dunford R, Genco RJ. The relationship between radiographic and clinical changes in the periodontium . *J Periodont Res* 1997;32:661-666. PMID: 9409461 DOI: 10.1111/j.1600-0765.1997.tb00576.x
9. Pepelassi EA, Tsiklakis K, Diamanti-Kipioti A. Radiographic detection and assessment of the periodontal endosseous defects. *J Clin Periodontol* 2000;27:224-30. PMID: 10783834 DOI: 10.1034/j.1600-051x.2000.027004224.x
10. Persson RE, Tzannetou S, Feloutzis AG, Bragger U, Persson GR, Lang NP. Comparison between panoramic and intra-oral radiographs for the assessment of alveolar bone levels in periodontal maintenance population. *J Clin Periodontol* 2003;30:833-9. PMID: 12956660 DOI: 10.1034/j.1600-051x.2003.00379.x

Digital imaging and Digital Subtraction Radiography:

11. Deas D, Pasquali L, Yuan C, Komman K. The relationship between probing attachment loss and computerised radiographic analysis in monitoring progression of periodontitis. *J Periodontol* 1991;66:135-141. PMID: 2027061 DOI: 10.1902/jop.1991.62.2.135
12. Reddy MS. Radiographic methods in the evaluation of periodontal therapy. *J Periodontol* 1992;63:1078-1084. PMID: 1479529 DOI: 10.1902/jop.1992.63.12s.1078

Review:

13. Jeffcoat MK, Chung Wang I, Reddy MS. Radiographic diagnosis in periodontics. *Periodontology 2000* 1995;7:54-68. PMID: 9567930 DOI: 10.1111/j.1600-0757.1995.tb00036.x

3.5 Furcation Assessment

Questions to be answered in this section:

- How is the assessment of furcation achieved?
1. Zappa U, Grosso C, et al. Clinical furcation diagnoses and interradicular bone defects. *J Periodontol* 1993; 64:219-227. PMID: 8463945 DOI: 10.1902/jop.1993.64.3.219
 2. Mealey, B, et al.: Use of furcal bone sounding to improve accuracy of furcation diagnosis. *J Periodontol* 1994;65:649-57. PMID: 7608840 DOI: 10.1902/jop.1994.65.7.649
 3. Hou G-L, Chen Y-M, et al. A new classification of molar furcation involvement based on the root trunk and horizontal and vertical bone loss. *Int J Periodontal Rest Dent* 1998;18:257-65. PMID: 9728108
 4. Muller H-P, Eger T. Furcation diagnosis. *J Clin Periodontol* 1999;26:485-98. PMID: 10450808 DOI: 10.1034/j.1600-051x.1999.260801.x

3.6 Mucogingival considerations

Questions to be answered in this session:

- Is keratinized gingiva important in maintaining gingival health?
- What are varying widths of keratinized gingiva and their effects on gingival health?

- How is the diagnostic accuracy of various periodontal measurements?
 1. Lang N, Löe H. The relationship between the width of keratinized gingiva and gingival health. *J Periodontol* 1972; 43:623-627. PMID: 4507712 DOI: 10.1902/jop.1972.43.10.623
 2. Miyasato M, Crigger M. Gingival condition in areas of minimal and appreciable width of attached gingiva. *J Clin Periodontol* 1977; 4:200-209. PMID: 330574 DOI: 10.1111/j.1600-051x.1977.tb02273.x
 3. Wennstrom J, Lindhe J. Plaque-induced gingival inflammation in the absence of attached gingiva in dogs. *J Clin Periodontol* 1983; 10:266-276. PMID: 6575981 DOI: 10.1111/j.1600-051x.1983.tb01275.x
 4. Kennedy J, Bird W. A longitudinal evaluation of varying widths of attached gingiva. *J Clin Periodontol* 1985; 12:667-675. PMID: 3902907 DOI: 10.1111/j.1600-051x.1985.tb00938.x
 5. Tenenbaum H, Tenenbaum M. A clinical study of the width of attached gingiva in the deciduous, transitional and permanent teeth. *J Clin Periodontol* 1986; 13:270-275. PMID: 3458723 DOI: 10.1111/j.1600-051x.1986.tb02221.x
 5. Wennstrom J. Lack of association between width of attached gingiva and development of soft tissue recession. *J Clin Periodontol* 1987; 14:181-184. PMID: 3470324 DOI: 10.1111/j.1600-051x.1987.tb00964.x
 6. Freedman, A.L., Green, K., Salkin, L.M., Stein, M.D. and Mellado, J.R.: An 18-year longitudinal study of untreated mucogingival defects. *J Periodontol* 1999; 70:1174-1176. PMID: 10534071 DOI: 10.1902/jop.1999.70.10.1174
 7. Rasperini G, et al. Decision making in gingival recession treatment: Scientific Evidence and Clinical Experience. *Clin Adv Periodontics* 2011;1:41-52. PMID: 32698553 DOI: 10.1902/cap.2011.100002
 8. Agudio G, Cortellini P, Buti J, Pini Prato G. Periodontal Conditions of Sites Treated With Gingival Augmentation Surgery Compared With Untreated Contralateral Homologous Sites: An 18- to 35-Year Long-Term Study. *J Periodontol.* 2016 Dec;87(12):1371-1378. PMID: 27523520 DOI: 10.1902/jop.2016.160284
 9. Agudio G, Chambrone L, Pini Prato G. Biologic Remodeling of Periodontal Dimensions of Areas Treated With Gingival Augmentation Procedure: A 25-Year Follow-Up Observation. *J Periodontol.* 2017 Jul;88(7):634-642. PMID: 28338390 DOI: 10.1902/jop.2017.170010

3.7 Sensitivity, specificity, and predictability of diagnostic tools

Questions to be answered in this session:

- How is the diagnostic accuracy of various periodontal measurements?
 1. Goodson J, Haffajee A. The relationship between attachment level loss and alveolar bone loss. *J Clin Periodontol.* 1984;11:348-359. PMID: 6585374 DOI: 10.1111/j.1600-051x.1984.tb01331.x
 2. Hardekopf J, et al. The "furcation arrow" - A reliable radiographic image? *J Periodontol.* 1986;58:258. PMID: 3473221 DOI: 10.1902/jop.1987.58.4.258
 3. Badersten A, Nilveus R, Egelberg J. Scores of plaque, bleeding, suppuration and probing depth to predict probing attachment loss. Five years of observation following non-surgical periodontal therapy. *J Clin Periodontol.* 1990;17:102-107. PMID: 2406291 DOI: 10.1111/j.1600-051x.1990.tb01070.x
 4. Claffey N, Nylund K, Kiger R, Garrett S, Egelberg J. Diagnostic predictability of scores of plaque, bleeding, suppuration and probing depth for probing attachment loss. 3.5 years of observation following initial periodontal therapy. *J Clin Periodontol.* 1990;17:108-114. PMID: 2406292 DOI: 10.1111/j.1600-051x.1990.tb01071.x
 5. Lang N, Adler R. Absence of bleeding on probing: An indicator of periodontal stability. *J Clin Periodontol.* 1990;17:714-721. PMID: 2262585 DOI: 10.1111/j.1600-051x.1990.tb01059.x
 6. Hausmann E, Allen K. What alveolar crest level on a bite-wing radiograph represents bone loss? *J Periodontol.* 1991;62:570-572. PMID: 1941497 DOI: 10.1902/jop.1991.62.9.570

7. Mealey B, Neubaum M, Butzin C. Use of furcal bone sounding to improve accuracy of furcation diagnosis. *J Periodontol.* 1994;65:649-657. PMID: 7608840 DOI: 10.1902/jop.1994.65.7.649
8. Rams TE, Listgarten MA, Slots J. Utility of radiographic crestal lamina dura for predicting periodontitis disease-activity. *J Clin Periodontol.* 1994;21:571-576. PMID: 7806671 DOI: 10.1111/j.1600-051x.1994.tb00745.x
9. Deas DE, Moritz AJ, Mealey BL, McDonnell HT, Powell CA. Clinical Reliability of the “Furcation Arrow” as a Diagnostic Marker. *J Periodontol.* 2006;77:1436-1441. PMID: 16881813 DOI: 10.1902/jop.2006.060034
10. Deke PI, Thornton-Evans GO, Wei L, Borgnakke WS, Dye BA. Accuracy of NHANES Periodontal Examination Protocols. *J Dent Res.* 2010;89(11):1208-1213. PMID: 20858782 DOI: 10.1177/0022034510377793

4. Epidemiology, risk assessment, and prognosis

4.1 Epidemiology of periodontal disease

Questions to be answered in this section:

- What is the prevalence of periodontal diseases ?
- What is the epidemiological association of periodontal disease and systemic diseases?

1. Albandar JM. Epidemiology and risk factors of periodontal diseases. *Dent Clin North Am.* 2005 Jul;49(3):517-32, v-vi. doi: 10.1016/j.cden.2005.03.003. PMID: 15978239.
2. Borgnakke WS, Ylöstalo PV, Taylor GW, Genco RJ. Effect of periodontal disease on diabetes: systematic review of epidemiologic observational evidence. *J Clin Periodontol.* 2013 Apr;40 Suppl 14:S135-52. doi: 10.1111/jcpe.12080. PMID: 23627324.
3. Demmer RT, Papapanou PN. Epidemiologic patterns of chronic and aggressive periodontitis. *Periodontol 2000.* 2010 Jun;53:28-44. doi: 10.1111/j.1600-0757.2009.00326.x. PMID: 20403103; PMCID: PMC3406186.
4. Dye BA. Global periodontal disease epidemiology. *Periodontol 2000.* 2012 Feb;58(1):10-25. doi: 10.1111/j.1600-0757.2011.00413.x. PMID: 22133364.
5. Eke PI, Page RC, Wei L, Thornton-Evans G, Genco RJ. Update of the case definitions for population-based surveillance of periodontitis. *J Periodontol.* 2012 Dec;83(12):1449-54. doi: 10.1902/jop.2012.110664. Epub 2012 Mar 16. PMID: 22420873; PMCID: PMC6005373.
6. Frencken JE, Sharma P, Stenhouse L, Green D, Laverty D, Dietrich T. Global epidemiology of dental caries and severe periodontitis - a comprehensive review. *J Clin Periodontol.* 2017 Mar;44 Suppl 18:S94-S105. doi: 10.1111/jcpe.12677. PMID: 28266116.
7. Kinane DF, Stathopoulou PG, Papapanou PN. Periodontal diseases. *Nat Rev Dis Primers.* 2017 Jun 22;3:17038. doi: 10.1038/nrdp.2017.38. PMID: 28805207.
8. Nazir MA. Prevalence of periodontal disease, its association with systemic diseases and prevention. *Int J Health Sci (Qassim).* 2017 Apr-Jun;11(2):72-80. PMID: 28539867; PMCID: PMC5426403.
9. Oliver RC, Brown LJ, Löe H. Periodontal diseases in the United States population. *J Periodontol.* 1998 Feb;69(2):269-78. doi: 10.1902/jop.1998.69.2.269. PMID: 9526927.
10. Papapanou PN. Periodontal diseases: epidemiology. *Ann Periodontol.* 1996;1(1):1-36. doi: 10.1902/annals.1996.1.1.1

11. Tonetti MS, Jepsen S, Jin L, Otomo-Corgel J. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: A call for global action. *J Clin Periodontol.* 2017 May;44(5):456-462. doi: 10.1111/jcpe.12732. Epub 2017 May 8. PMID: 28419559.

4.2 Risk assessment and prognosis

Questions to be answered in this section:

- What are the tools of risk assessment in periodontal diseases?
- How do we predict the risk of periodontal disease progression?
- What is prognosis and how do we assess periodontal prognosis
- How accurate are our periodontal prognosis systems ?

1. Axelsson P, Nyström B, Lindhe J. The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *J Clin Periodontol.* 2004 Sep;31(9):749-57. doi: 10.1111/j.1600-051X.2004.00563.x. PMID: 15312097.
2. Chambrone L, Chambrone D, Lima LA, Chambrone LA. Predictors of tooth loss during long-term periodontal maintenance: a systematic review of observational studies. *J Clin Periodontol.* 2010 Jul;37(7):675-84. doi: 10.1111/j.1600-051X.2010.01587.x. Epub 2010 May 26. PMID: 20528960.
3. Eickholz P, Kaltschmitt J, Berbig J, Reitmeir P, Pretzl B. Tooth loss after active periodontal therapy. I: patient-related factors for risk, prognosis, and quality of outcome. *J Clin Periodontol.* 2008 Feb;35(2):165-74. doi: 10.1111/j.1600-051X.2007.01184.x. PMID: 18199150.
4. Eke PI, Wei L, Thornton-Evans GO, Borrell LN, Borgnakke WS, Dye B, Genco RJ. Risk Indicators for Periodontitis in US Adults: NHANES 2009 to 2012. *J Periodontol.* 2016 Oct;87(10):1174-85. doi: 10.1902/jop.2016.160013. Epub 2016 Jul 1. PMID: 27367420.
5. Genco RJ, Borgnakke WS. Risk factors for periodontal disease. *Periodontol 2000.* 2013 Jun;62(1):59-94. doi: 10.1111/j.1600-0757.2012.00457.x. PMID: 23574464.
6. Grossi SG, Genco RJ, Machtei EE, Ho AW, Koch G, Dunford R, Zambon JJ, Hausmann E. Assessment of risk for periodontal disease. II. Risk indicators for alveolar bone loss. *J Periodontol.* 1995 Jan;66(1):23-9. doi: 10.1902/jop.1995.66.1.23. PMID: 7891246.
7. Goldman MJ, Ross IF, Goteiner D. Effect of periodontal therapy on patients maintained for 15 years or longer. A retrospective study. *J Periodontol.* 1986 Jun;57(6):347-53. doi: 10.1902/jop.1986.57.6.347. PMID: 3522850.
8. Haffajee AD, Socransky SS, Lindhe J, Kent RL, Okamoto H, Yoneyama T. Clinical risk indicators for periodontal attachment loss. *J Clin Periodontol.* 1991 Feb;18(2):117-25. doi: 10.1111/j.1600-051x.1991.tb01700.x. PMID: 2005225.
9. Hirschfeld L, Wasserman B. A long-term survey of tooth loss in 600 treated periodontal patients. *J Periodontol.* 1978 May;49(5):225-37. doi: 10.1902/jop.1978.49.5.225. PMID: 277674.
10. Kwok V, Caton JG. Commentary: prognosis revisited: a system for assigning periodontal prognosis. *J Periodontol.* 2007 Nov;78(11):2063-71. doi: 10.1902/jop.2007.070210. PMID: 17970671.
11. McFall WT Jr. Tooth loss in 100 treated patients with periodontal disease. A long-term study. *J Periodontol.* 1982 Sep;53(9):539-49. doi: 10.1902/jop.1982.53.9.539. PMID: 6957591.

12. McGuire MK. Prognosis versus actual outcome: a long-term survey of 100 treated periodontal patients under maintenance care. *J Periodontol.* 1991 Jan;62(1):51-8. doi: 10.1902/jop.1991.62.1.51. PMID: 2002432.
13. McGuire MK, Nunn ME. Prognosis versus actual outcome. II. The effectiveness of clinical parameters in developing an accurate prognosis. *J Periodontol.* 1996 Jul;67(7):658-65. doi: 10.1902/jop.1996.67.7.658. PMID: 8832476.
14. McGuire MK, Nunn ME. Prognosis versus actual outcome. III. The effectiveness of clinical parameters in accurately predicting tooth survival. *J Periodontol.* 1996 Jul;67(7):666-74. doi: 10.1902/jop.1996.67.7.666. PMID: 8832477.
15. McGuire MK, Nunn ME. Prognosis versus actual outcome. IV. The effectiveness of clinical parameters and IL-1 genotype in accurately predicting prognoses and tooth survival. *J Periodontol.* 1999 Jan;70(1):49-56. doi: 10.1902/jop.1999.70.1.49. PMID: 10052770.
16. Lang NP, Adler R, Joss A, Nyman S. Absence of bleeding on probing. An indicator of periodontal stability. *J Clin Periodontol.* 1990 Nov;17(10):714-21. doi: 10.1111/j.1600-051x.1990.tb01059.x. PMID: 2262585.
17. Lang NP, Schätzle MA, Löe H. Gingivitis as a risk factor in periodontal disease. *J Clin Periodontol.* 2009 Jul;36 Suppl 10:3-8. doi:10.1111/j.1600-051X.2009.01415.x. PMID: 19432625.
18. Peruzzo DC, Benatti BB, Ambrosano GM, Nogueira-Filho GR, Sallum EA, Casati MZ, Nociti FH Jr. A systematic review of stress and psychological factors as possible risk factors for periodontal disease. *J Periodontol.* 2007 Aug;78(8):1491-504. doi: 10.1902/jop.2007.060371. PMID: 17668968.
19. Tonetti MS, Van Dyke TE; working group 1 of the joint EFP/AAP workshop. Periodontitis and atherosclerotic cardiovascular disease: consensus report of the Joint EFP/AAP Workshop on Periodontitis and Systemic Diseases. *J Periodontol.* 2013 Apr;84(4 Suppl):S24-9. doi: 10.1902/jop.2013.1340019. PMID: 23631582.
20. Van Dyke TE, Sheilesh D. Risk factors for periodontitis. *J Int Acad Periodontol.* 2005 Jan;7(1):3-7. PMID: 15736889; PMCID: PMC1351013.
21. Herrera D, Sanz M, Shapira L, Brotons C, Chapple I, Frese T, Graziani F, Hobbs FDR, Huck O, Hummers E, Jepsen S, Kravtchenko O, Madianos P, Molina A, Ungan M, Vilaseca J, Windak A, Vinker S. Association between periodontal diseases and cardiovascular diseases, diabetes and respiratory diseases: Consensus report of the Joint Workshop by the European Federation of Periodontology (EFP) and the European arm of the World Organization of Family Doctors (WONCA Europe). *J Clin Periodontol.* 2023 Jun;50(6):819-841. doi: 10.1111/jcpe.13807. Epub 2023 Mar 22. PMID: 36935200.

5. Diagnosis and Treatment Planning

Questions to be answered in this section:

- What are the histological and clinical criteria in defining gingival health?

5.1 Gingival Health

1. Brecx MC, Schlegel K, Gehr P, Lang NP. Comparison between histological and clinical parameters during human experimental gingivitis. *J Periodontal Res.* 1987;22:50–57. PMID: 2950227, DOI: 10.1111/j.1600-0765.1987.tb01539.x
2. Brecx MC, Gautschi M, Gehr P, Lang NP. Variability of histologic criteria in clinically healthy human gingiva. *J Periodontal Res.* 1987;22:468–472. doi:10.1111/j.1600-0765.1987.tb02057.x. PMID: 2963106.
3. Lang NP, Bartold PM. Periodontal health. *J Periodontol.* 2018;89(Suppl 1):S9–S16.

- Chapple ILC, Mealey BL, et al. Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Periodontol*. 2018;89(Suppl 1):S74–S84. <https://doi.org/10.1002/JPER.17-0719>

5.2 – Gingivitis- Biofilm induced and non-biofilm induced

Questions to be answered in this section:

- What are the histological and clinical criteria in defining gingivitis?
- What are the different histological stages of gingivitis ?

Biofilm-induced

1. Löe H, Theilade E, Jensen SB. Experimental gingivitis in man. *J Periodontol*. 1965;36:177–187. PMID: 14296927 DOI: 10.1902/jop.1965.36.3.177
2. Page RC, Schroeder HE. Pathogenesis of inflammatory periodontal disease. *Lab Invest*. 1976;33:235–249. PMID: 765622.
3. Mariotti A. Dental plaque-induced gingival diseases. *Ann Periodontol*. 1999 Dec;4(1):7-19. doi: 10.1902/annals.1999.4.1.7. PMID: 10863371.
4. Page RC, Kornman KS. The pathogenesis of human periodontitis: An introduction. *Periodontol 2000*. 1997;14:9–11. PMID: 9567963. DOI: 10.1111/j.1600-0757.1997.tb00189.x
5. Lang NP, Schätzle MA, Löe H. Gingivitis as a risk factor in periodontal disease. *J Clin Periodontol*. 2009;36(Suppl.10):3–8. PMID: 19432625 DOI:10.1111/j.1600-051X.2009.01415.x
6. Murakami S, Mealey BL, Mariotti A, Chapple ILC. Dental plaque-induced gingival conditions. *J Clin Periodontol*. 2018 Jun;45 Suppl 20:S17-S27. doi: 10.1111/jcpe.12937. PMID: 29926503.
7. Trombelli L, Farina R, Silva CO, Tatakis DN. Plaque-induced gingivitis: Case definition and diagnostic considerations. *J Periodontol*. 2018;89(Suppl 1):S46–S73. <https://doi.org/10.1002/JPER.17-0576>

Non-Biofilm Induced

1. Holmstrup P. Non-plaque-induced gingival lesions. *Ann Periodontol*. 1999 Dec;4(1):20-31. doi: 10.1902/annals.1999.4.1.20. PMID: 10863372
2. Holmstrup P, Plemons J, Meyle J. Non-plaque-induced gingival diseases. *J Periodontol*. 2018;89(Suppl 1):S28–S45. <https://doi.org/10.1002/JPER.17-0163>

5.3. Gingival Enlargement

Questions to be answered in this section:

- What is the prevalence and etiopathogenesis of drug induced gingival enlargements?
- What is the gingival fibromatosis and its etiology?

1. Ramfjord S. The histopathology of inflammatory gingival enlargement. *Oral Surg Oral Med Oral Pathol*. 1953 Apr;6(4):516-35. doi: 10.1016/0030-4220(53)90117-0. PMID: 13055238.

2. Nuki K, Cooper SH. The role of inflammation in the pathogenesis of gingival enlargement during the administration of diphenylhydantoin sodium in cats. *J Periodontal Res.* 1972;7(2):102-10. doi: 10.1111/j.1600-0765.1972.tb00635.x. PMID: 4272036.
3. Ciancio SG, Yaffe SJ, Catz CC. Gingival hyperplasia and diphenylhydantoin. *J Periodontol.* 1972 Jul;43(7):411-4. doi: 10.1902/jop.1972.43.7.411. PMID: 4504524.
4. Pihlstrom BL, Carlson JF, Smith QT, Bastien SA, Keenan KM. Prevention of phenytoin associated gingival enlargement--a 15-month longitudinal study. *J Periodontol.* 1980 Jun;51(6):311-7. doi: 10.1902/jop.1980.51.6.311. PMID: 6930469.
5. Lucas RM, Howell LP, Wall BA. Nifedipine-induced gingival hyperplasia. A histochemical and ultrastructural study. *J Periodontol.* 1985 Apr;56(4):211-5. doi: 10.1902/jop.1985.56.4.211. PMID: 3858503.
6. Bennett JA, Christian JM. Cyclosporine-induced gingival hyperplasia: case report and literature review. *J Am Dent Assoc.* 1985 Aug;111(2):272-3. doi: 10.14219/jada.archive.1985.0081. PMID: 3900171.
7. Butler RT, Kalkwarf KL, Kaldahl WB. Drug-induced gingival hyperplasia: phenytoin, cyclosporine, and nifedipine. *J Am Dent Assoc.* 1987 Jan;114(1):56-60. doi: 10.14219/jada.archive.1987.0050. PMID: 3468168.
8. Clark D. Gingival fibromatosis and its related syndromes. A review. *J Can Dent Assoc.* 1987 Feb;53(2):137-40. PMID: 3545406.
9. Ramer M, Marrone J, Stahl B, Burakoff R. Hereditary gingival fibromatosis: identification, treatment, control. *J Am Dent Assoc.* 1996 Apr;127(4):493-5. doi: 10.14219/jada.archive.1996.0242. PMID: 8655871.
10. Seymour RA, Thomason JM, Ellis JS. The Pathogenesis of drug-induced gingival overgrowth. *J Clin Periodontol.* 1996;23:165.
11. Hallmon WW, Rossman JA. The role of drugs in the pathogenesis of gingival overgrowth. *Periodontol 2000.* 1999;21:176.

Review:

12. Coletta RD, Graner E. Hereditary gingival fibromatosis: a systematic review. *J Periodontol.* 2006 May;77(5):753-64. doi: 10.1902/jop.2006.050379. PMID: 16671866.

5.4 Necrotizing Periodontal Diseases

Questions to be answered in this section:

What are etiological, histological and clinical findings for necrotizing periodontal diseases?

1. Herrera D, Retamal-Valdes B, Alonso B, Feres M. Acute periodontal lesions (periodontal abscesses and necrotizing periodontal diseases) and endo-periodontal lesions. *J Periodontol.* 2018 Jun;89 Suppl 1:S85-S102. doi: 10.1002/JPER.16-0642. PMID: 29926942.
2. Listgarten MA. Electron microscopic observations on the bacterial flora of acute necrotizing ulcerative gingivitis. *J Periodontol (1930).* 1965 Jul-Aug;36:328-39. doi: 10.1902/jop.1965.36.4.328. PMID: 14326701.
3. Wilton JM, Ivanyi L, Lehner T. Cell-mediated immunity and humoral antibodies in acute ulcerative gingivitis. *J Periodontal Res.* 1971;6:9–16. PMID: 4255159 DOI: 10.1111/j.1600-0765.1971.tb00582.x
4. Jimenez M, Baer PN. Necrotizing ulcerative gingivitis in children: a 9 year clinical study. *J Periodontol.* 1975;46:715–720. PMID: 1060749 DOI: 10.1902/jop.1975.46.12.715

5. Hooper PA, Seymour GJ. The histopathogenesis of acute ulcerative gingivitis. *J Periodontol*. 1979;50:419–423. PMID: 383943 DOI: 10.1902/jop.1979.50.8.419
6. Loesche WJ, Syed SA, Laughon BE, Stoll J. The bacteriology of acute necrotizing ulcerative gingivitis. *J Periodontol*. 1982;53:223–230. PMID: 6122728 DOI: 10.1902/jop.1982.53.4.223
7. Courtois GJ 3rd, Cobb CM, Killoy WJ. Acute necrotizing ulcerative gingivitis. A transmission electron microscope study. *J Periodontol*. 1983;54:671–679. PMID: 6580420 DOI: 10.1902/jop.1983.54.11.671
8. Stevens AW Jr, Cogen RB, Cohen-Cole S, Freeman A. Demographic and clinical data associated with acute necrotizing ulcerative gingivitis in a dental school population (ANUG-demographic and clinical data). *J Clin Periodontol*. 1984 Sep;11(8):487-93. doi: 10.1111/j.1600-051x.1984.tb00900.x. PMID: 6592176.
9. Johnson BD, Engel D. Acute necrotizing ulcerative gingivitis. A review of diagnosis, etiology and treatment. *J Periodontol*. 1986 Mar;57(3):141-50. doi: 10.1902/jop.1986.57.3.141. PMID: 3514841.
10. Melnick SL, Alvarez JO, Navia JM, Cogen RB, Roseman JM. A case-control study of plasma ascorbate and acute necrotizing ulcerative gingivitis. *J Dent Res*. 1988 May;67(5):855-60. doi: 10.1177/00220345880670051201. PMID: 3163353.
11. Williams CA, Winkler JR, Grassi M, Murray PA. HIV-associated periodontitis complicated by necrotizing stomatitis. *Oral Surg Oral Med Oral Pathol*. 1990 Mar;69(3):351-5. doi: 10.1016/0030-4220(90)90298-7. PMID: 2314860.
12. MacCarthy D, Claffey N. Acute necrotizing ulcerative gingivitis is associated with attachment loss. *J Clin Periodontol*. 1991 Nov;18(10):776-9. doi: 10.1111/j.1600-051x.1991.tb00071.x. PMID: 1753002.
13. Horning GM, Cohen ME. Necrotizing ulcerative gingivitis, periodontitis, and stomatitis: clinical staging and predisposing factors. *J Periodontol*. 1995 Nov;66(11):990-8. doi: 10.1902/jop.1995.66.11.990. PMID: 8558402.
14. Lang N, Soskolne WA, Greenstein G, et al. Consensus report: necrotizing periodontal diseases. *Ann Periodontol*. 1999; 4:78.
15. Novak MJ. Necrotizing ulcerative periodontitis. *Ann Periodontol*. 1999 Dec;4(1):74-8. doi: 10.1902/annals.1999.4.1.74. PMID: 10863377.
16. Feller L, Lemmer J. Necrotizing gingivitis as it relates to HIV infection: a review of the literature. *Periodontal Prac Today*. 2005;2:31–37
17. Corbet EF. Diagnosis of acute periodontal lesions. *Periodontol 2000*. 2004;34:204-16. doi: 10.1046/j.0906-6713.2003.003432.x. PMID: 14717863.

5.5 Molar-Incisor Pattern/ Aggressive Periodontitis

Questions to be answered from this section:

- Describe the criteria which classifies aggressive periodontitis as a distinct entity. (1999 International Workshop for a Classification of Periodontal Diseases and 2017 World Workshop)
- Discuss the characteristics of the patient population most prone to aggressive periodontitis and the frequency, severity and progression of the disease process.
- Describe the clinical features of localized and generalized aggressive periodontitis.
- Describe the clinical features of the previously reported “prepubertal and rapidly progressive periodontitis” and determine where these entities fall in the classification of “aggressive periodontitis”³⁴
- Discuss the microbiology and immunology associated with the pathogenesis of aggressive periodontitis.

- Explain the rationale for treatment of patients with aggressive periodontitis. Include scientific evidence for the use of antibiotics.
- What is the definition of a “refractory periodontitis” case? How are these cases classified according to the 1999 International Workshop?
- Describe the microbiology, immunology, and socioeconomics associated with these cases.
- What treatment options are available to treat these patients? How predictable are these therapies?

CClassification:

1. Tonetti MS, Mombelli A. Early-onset periodontitis. *Ann Periodontol.* 1999;4(1):39-52.
2. Armitage GC. Development of a classification system for periodontal diseases and conditions. *Ann Periodontol.* 1999;4(1):1-6.
3. Fine DH, Patil AG, Loos BG. Classification and diagnosis of aggressive periodontitis. *J Periodontol.* 2018;89(Suppl 1):S103–S119. <https://doi.org/10.1002/JPER.16-0712>
4. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *J Periodontol.* 2018;89(Suppl 1):S159–S172. <https://doi.org/10.1002/JPER.18-0006>

CClinical features; etiology; pathogenesis:

5. Meng H, Xu L, Li Q, Han J, Zhao Y. Determinants of host susceptibility in aggressive periodontitis. *Periodontol 2000.* 2007;43:133-159.
6. Oh T-J, Eber R, Wang H-L. Periodontal diseases in the child and adolescent. *J Clin Periodontol.* 2002;29:400-410.
7. Schenkein HA, Van Dyke TE. Early-onset periodontitis: Systemic aspects of etiology and pathogenesis. *Periodontology 2000.* 1994;6:7-25.
8. Baer PN. The case of periodontosis as a clinical entity. *J Periodontol.* 1971;42:516-520.
9. Page RC, Altman LC, et al. Rapidly progressive periodontitis: A distinct clinical condition. *J Periodontol.* 1983;54:197-209.
11. Page RC, Bowen T, et al. Prepubertal periodontitis. I. Definition of a clinical disease entity. *J Periodontol.* 1983;54:257-271.

Epidemiology:

11. Löe H, Brown LJ. Early-onset periodontitis in the United States of America. *J Periodontol.* 1991;62:608-616.

Microbiology/immunology:

12. Kantarci A, Oyaizu K, Van Dyke TE. Neutrophil-mediated tissue injury in periodontal disease pathogenesis: Findings from localized aggressive periodontitis. *J Periodontol.* 2003;74:66-75.
13. Gillett R, Johnson NW. Bacterial invasion of the periodontium in a case of juvenile periodontitis. *J Clin Periodontol.* 1982;9:93-100.
14. Christersson LA, et al. Tissue localization of *Aggregatibacter actinomycetemcomitans* in human periodontitis. *J Periodontol.* 1987;58:540-545.

15. Albandar JM, Brown LJ, Löe H. Putative periodontal pathogens in subgingival plaque of young adults with and without early-onset periodontitis. *J Periodontol.* 1997;68:973-981.
16. Mandell RL, Ebersole JL, Socransky SS. Clinical immunologic and microbiologic features of active disease sites in juvenile periodontitis. *J Clin Periodontol.* 1987;14:534-540.
17. Klinfelder JW, Muller RF, Lange DE. Intraoral persistence of *Aggregatibacter actinomycetemcomitans* in periodontally healthy subjects following treatment of diseased family members. *J Clin Periodontol.* 1999;26:583-589.
18. Kamma JJ, Nakou M, Baehni PC. Clinical and microbiological characteristics of smokers with early-onset periodontitis. *J Periodontol Res.* 1999;34(1):25-33.

Treatment:

19. Slots N, Rosling BG. Suppression of periodontal pathic microflora in localized juvenile periodontitis by systemic tetracycline. *J Clin Periodontol.* 1983;10:465-486.
20. Kornman KS, Robertson PB. Clinical and microbiological evaluation of therapy for juvenile periodontitis. *J Periodontol.* 1985;56:443-446.
21. Lindhe J, Liljenberg B. Treatment of localized juvenile periodontitis. Results after 5 years. *J Clin Periodontol.* 1984;11:399-410.
22. Christersson LA, Slots J, et al. Microbiological and clinical effects of surgical treatment of localized juvenile periodontitis. *J Clin Periodontol.* 1985;12:465-476.
23. Van Winkelhoff AJ, Rodenburg JP, et al. Metronidazole plus amoxycillin in the treatment of *Aggregatibacter actinomycetemcomitans*-associated periodontitis. *J Clin Periodontol.* 1989;16:128-131.
24. Novak MJ, Polson AM, Adair SM. Tetracycline therapy in patients with early juvenile periodontitis. *J Periodontol.* 1988;59:366-372.
25. Novak MJ, Stamatelakys C, Adair SM. Resolution of early lesions of juvenile periodontitis with tetracycline therapy alone: long-term observations of 4 cases. *J Periodontol.* 1991;62:628-633.
26. Saxen L, Asikainen S. Metronidazole in the treatment of localized juvenile periodontitis. *J Clin Periodontol.* 1993;20:166-171.
27. Wennstrom A, Wennstrom J, Lindhe J. Healing following surgical and non-surgical treatment of juvenile periodontitis. *J Clin Periodontol.* 1986;13:869-882.
28. Palmer RM, Watts TLP, Wilson RF. A double-blind trial of tetracycline in the management of early-onset periodontitis. *J Clin Periodontol.* 1996;23:670-674.
29. Tonoco EMB, et al. Clinical and microbiologic effects of adjunctive antibiotics in the treatment of localized juvenile periodontitis. *J Periodontol.* 1998;69:1355-1363.

Refractory periodontitis:

30. Kornman K. Refractory periodontitis: Critical questions in clinical management. *J Clin Periodontol.* 1996;23:293-298.
31. Magnusson I, et al. Treatment of subjects with refractory periodontal disease. *J Clin Periodontol.* 1994;21:628-637.

32. Magnusson I, et al. Clinical, microbiologic and immunological characteristics of subjects with “refractory” periodontal disease. *J Clin Periodontol.* 1991;18:291-299.
33. Barone A, Sbordone L, Ramaglia L, Ciaglia RN. Microbiota associated with refractory periodontitis. *Minerva Stomatol.* 1999;48:191-201.
34. MacFarlane GS, Herzberg MC, Wolff LF, Hardie NA. Refractory periodontitis associated with abnormal polymorphonuclear leukocyte phagocytosis and cigarette smoking. *J Periodontol.* 1992;63:908-913.
35. Magnusson K, et al. Effect of non-surgical periodontal therapy combined with adjunctive antibiotics in subjects with “refractory” periodontal disease. *J Clin Periodontol.* 1989;16:647-653.
36. Soder B, Nelich U, Jin LJ. Longitudinal effect of non-surgical treatment and systemic metronidazole for 1 week in smokers and non-smokers with refractory periodontitis. *J Periodontol.* 1999;70:761-771.

5.6 Periodontitis Staging and Grading

Questions to be answered in this section:

What is the Staging and Grading criteria for periodontitis according to the 2017 World Workshop on Periodontal Disease Classification System?

1. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *J Clin Periodontol.* 2018;45 Suppl 20: S149-S161. PMID: 29926495. doi: 10.1111/jcpe.12945.
2. Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *J Periodontol.* 2018;89(Suppl 1): S159-S172. PMID: 29926952. doi: 10.1002/JPER.18-0006.

5.7 Acute Periodontal Lesions

Questions to be answered in this section:

- What are the different acute periodontal lesions?
- What are the signs and symptoms of acute periodontal lesions?
- How do you treat acute periodontal lesions?

1. Parameter on acute periodontal diseases. American Academy of Periodontology. *J Periodontol.* 2000;71(5 Suppl):863-866. PMID: 10875694. doi: 10.1902/jop.2000.71.5-S.863.
2. Herrera D, Alonso B, de Arriba L, Santa Cruz I, Serrano C, Sanz M. Acute periodontal lesions. *Periodontol 2000.* 2014;65(1):149-177. doi: 10.1111/prd.12022.
3. Amir J, Harel L, Smetana Z, Varsano I. Treatment of herpes simplex gingivostomatitis with aciclovir in children: a randomised double blind placebo controlled study. *BMJ.* 1997;314(7097):1800-1803. PMID: 9224082. doi: 10.1136/bmj.314.7097.
4. Bermejo-Fenoll A, Sánchez-Pérez A. Necrotising periodontal diseases. *Med Oral Patol Oral Cir Bucal.* 2004;9 Suppl:114-9; 108-119. PMID: 15580128.
5. Singh P. Endo-Perio Dilemma: A Brief Review. *Dent Res J.* 2011;8(1):39-47. PMID: 22132014.
6. Herrera D, Retamal-Valdes B, Alonso B, Feres M. Acute periodontal lesions (periodontal abscesses and necrotizing periodontal diseases) and endo-periodontal lesions. *J Periodontology.* 2018;89:S85-S102. PMID: 29926942. doi: 10.1002/JPER.16-0642.

5.8 Mucogingival deformities and conditions, gingival phenotype, gingival recessions, altered eruption pattern, aberrant frenal attachment.

Questions to be answered in this section:

- What are the case definitions and criteria to diagnose mucogingival conditions?
 - How do we classify gingival recessions?
 - What criteria of gingival recessions are utilized in developing treatment plans for root coverage?
1. Pierpaolo Cortellini, Nabil F Bissada. Mucogingival conditions in the natural dentition: Narrative review, case definitions, and diagnostic considerations. *J Periodontol.* 2018;89 Suppl 1:S204-S213. PMID: 29926948, DOI: 10.1002/JPER.16-0671.
 2. Francesco Cairo, Michele Nieri, Sandro Cincinelli, Jana Mervelt, Umberto Pagliaro. The interproximal clinical attachment level to classify gingival recessions and predict root coverage outcomes: an explorative and reliability study. *J Clin Periodontol.* 2011;38(7):661-6. PMID: 21507033, DOI: 10.1111/j.1600-051X.2011.01732.x
 3. Giovanni Zucchelli, Guido Gori, Monica Mele, Martina Stefanini, Claudio Mazzotti, Matteo Marzadori, Lucio Montebugnoli, Massimo De Sanctis. Non-carious cervical lesions associated with gingival recessions: a decision-making process. *J Periodontol.* 2011; 82(12):1713-24. PMID: 21542735 DOI: 10.1902/jop.2011.110080

6. Biofilm Control & Mechanical Therapy

6.1 Oral Physiotherapy

1. O'Leary TJ, Shafer WG, Swenson HM, Nesler DC. Possible penetration of crevicular tissue from oral hygiene procedures. II. Use of the toothbrush. *J Periodontol.* 1970;41:163-164. doi: 10.1902/jop.1970.41.3.163. PMID: 5265937.
2. Lang NP, Cumming BR, Löe H. Toothbrushing frequency as it relates to plaque development and gingival health. *J Periodontol.* 1973;44:396-405. doi: 10.1902/jop.1973.44.7.396. PMID: 4514570.
3. Waerhaug J. The interdental brush and its place in operative and crown and bridge dentistry. *J Oral Rehabil.* 1976;3:107-113. doi: 10.1111/j.1365-2842.1976.tb00934.x. PMID: 1066443.
4. Kreifeldt JG, Hill PH, Calisti LJ. A systematic study of the plaque removal efficiency of worn toothbrushes. *J Dent Res.* 1980;59:2047-2055. doi: 10.1177/00220345800590120401. PMID: 6941992.
5. Waerhaug J. Effect of toothbrushing on subgingival plaque formation. *J Periodontol.* 1981;52:30-34. doi: 10.1902/jop.1981.52.1.30. PMID: 6782227.
6. Lamberts DM, Wunderlich RC, Caffesse RG. The effect of waxed and unwaxed dental floss on gingival health. Part I. Plaque removal and gingival response. *J Periodontol.* 1982;53:393-396. doi: 10.1902/jop.1982.53.6.393. PMID: 6955502.
7. Löe H, Anerud A, Boysen H, Morrison E. Natural history of periodontal disease in man. Rapid, moderate and no loss of attachment in Sri Lankan laborers 14 to 46 years of age. *J Clin Periodontol.* 1986;13:431-445. doi: 10.1111/j.1600-051x.1986.tb01487.x. PMID: 3487557.
8. Graves RC, Disney JA, Stamm JW. Comparative effectiveness of flossing and brushing in reducing interproximal bleeding. *J Periodontol.* 1989;60:243-247. doi: 10.1902/jop.1989.60.5.243. PMID: 2786959.
9. Flemmig TF, Newman MG, Doherty FM, Grossman E, Meckel AH, Bakdash MB. Supragingival irrigation with 0.06% chlorhexidine in naturally occurring gingivitis. I. 6 month clinical observations. *J Periodontol.* 1990;61:112-117. doi: 10.1902/jop.1990.61.2.112. PMID: 2313527.

10. Overholser CD, Meiller TF, DePaola LG, Minah GE, Niehaus C. Comparative effects of 2 chemotherapeutic mouthrinses on the development of supragingival dental plaque and gingivitis. *J Clin Periodontol*. 1990;17:575-579. PMID: 2212088.
11. Kiger RD, Nylund K, Feller RP. A comparison of proximal plaque removal using floss and interdental brushes. *J Clin Periodontol*. 1991;18:681-684. doi: 10.1111/j.1600-051x.1991.tb00109.x. PMID: 1960236.
12. Hellstadius K, Asman B, Gustafsson A. Improved maintenance of plaque control by electrical toothbrushing in periodontitis patients with low compliance. *J Clin Periodontol*. 1993;20:235-237. doi: 10.1111/j.1600-051x.1993.tb00350.x. PMID: 8473531.
13. Knight NN, Lie T, Clark SM, Adams DF. Hypersensitive dentin: testing of procedures for mechanical and chemical obliteration of dentinal tubuli. *J Periodontol*. 1993;64:366-373. doi: 10.1902/jop.1993.64.5.366. PMID: 8515366.
14. Hellstadius K, Asman B, Gustafsson A. Improved maintenance of plaque control by electrical toothbrushing in periodontitis patients with low compliance. *J Clin Periodontol*. 1993 Apr;20(4):235-7. doi: 10.1111/j.1600-051x.1993.tb00350.x. PMID: 8473531.
15. Van der Weijden GA, Timmerman MF, Nijboer A, Lie MA, Van der Velden U. A comparative study of electric toothbrushes for the effectiveness of plaque removal in relation to toothbrushing duration. Timerstudy. *J Clin Periodontol*. 1993 Aug;20(7):476-81. doi: 10.1111/j.1600-051x.1993.tb00394.x. PMID: 8354721.
16. Rapley JW, Killoy WJ. Subgingival and interproximal plaque removal using a counter-rotational electric toothbrush and a manual toothbrush. *Quintessence Int*. 1994 Jan;25(1):39-42. PMID: 8190879.
17. Tritton CB, Armitage GC. Comparison of a sonic and a manual toothbrush for efficacy in supragingival plaque removal and reduction of gingivitis. *J Clin Periodontol*. 1996;23:641-648. doi: 10.1111/j.1600-051x.1996.tb00588.x. PMID: 8841896.
18. Van der Weijden GA, Timmerman MF, Reijerse E, Snoek CM, Van der Velden U. Comparison of an oscillating/rotating electric toothbrush and a 'sonic' toothbrush in plaque-removing ability. A professional toothbrushing and supervised brushing study. *J Clin Periodontol*. 1996 Apr;23(4):407-11. doi: 10.1111/j.1600-051x.1996.tb00565.x. PMID: 8739175.
19. Felo A, Shibly O, Ciancio SG, Lauciello FR, Ho A. Effects of subgingival chlorhexidine irrigation on peri-implant maintenance. *Am J Dent*. 1997;10:107-110. PMID: 9545899.
20. Danser MM, Timmerman MF, IJzerman Y, van der Velden U, Warren PR, van der Weijden FA. A comparison of electric toothbrushes in their potential to cause gingival abrasion of oral soft tissues. *Am J Dent*. 1998 Sep;11(Spec No):S35-9. PMID: 10530098.
21. Haffajee AD, Thompson M, Torresyap G, Guerrero D, Socransky SS. Efficacy of manual and powered toothbrushes (I). Effect on clinical parameters. *J Clin Periodontol*. 2001;28:937-946. doi: 10.1034/j.1600-051x.2001.028010937.x.
22. Sicilia A, Arregui I, Gallego M, Cabezas B, Cuesta S. A systematic review of powered vs manual toothbrushes in periodontal cause-related therapy. *J Clin Periodontol*. 2002;29 Suppl 3:39-54; discussion 90-1. doi: 10.1034/j.1600-051x.29.s-3.1.x. PMID: 12787206.
23. Warren PR, Cugini MA, Chater BV, Strate J. A review of the clinical efficacy of the Oral-B oscillating/rotating power toothbrush and the Philips Sonicare toothbrush in normal subject populations. *Int Dent J*. 2004;54:429-437. doi: 10.1111/j.1875-595x.2004.tb00300.x.

24. Axelsson P, Nystrom B, Lindhe J. The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *J Clin Periodontol.* 2004;31:749-757. doi: 10.1111/j.1600-051X.2004.00563.x. PMID: 15312097.
25. Schmidt JC, Zaugg C, Weiger R, Walter C. Brushing without brushing?--a review of the efficacy of powered toothbrushes in noncontact biofilm removal. *Clin Oral Investig.* 2013 Apr;17(3):687-709. doi: 10.1007/s00784-012-0836-8. PMID: 23001187.
26. Wainwright J, Sheiham A. An analysis of methods of toothbrushing recommended by dental associations, toothpaste and toothbrush companies and in dental texts. *Br Dent J.* 2014 Aug;217(3):E5. doi: 10.1038/sj.bdj.2014.651. PMID: 25104719.
27. Heasman PA, Holliday R, Bryant A, Preshaw PM. Evidence for the occurrence of gingival recession and non-carious cervical lesions as a consequence of traumatic toothbrushing. *J Clin Periodontol.* 2015;42 Suppl 16:S237-255. doi: 10.1111/jcpe.12330. PMID: 25495508.
28. West NX, Seong J, Davies M. Management of dentine hypersensitivity: efficacy of professionally and self-administered agents. *J Clin Periodontol.* 2015;42 Suppl 16:S256-302. doi: 10.1111/jcpe.12336. PMID: 25495777.
29. Lavigne SE, Doupe MB, Iacopino AM, Mahmud S, Elliott L. The effects of power toothbrushing on periodontal inflammation in a Canadian nursing home population: A randomized controlled trial. *Int J Dent Hyg.* 2017;15:328-334. doi: 10.1111/idh.12268.

Reviews:

1. Tan AE. Disclosing agents in plaque control: a review. *J West Soc Periodontol Periodontal Abstr.* 1981;29:81-86. PMID: 6101106.
2. Greenstein G. Position paper: The role of supra- and subgingival irrigation in the treatment of periodontal diseases. *J Periodontol.* 2005;76:2015-2027. doi: 10.1902/jop.2005.76.11.2015. PMID: 16274324.
3. Deacon SA, Glenny AM, Deery C, Robinson PG, Heanue M, Walmsley AD, Shaw WC. Different powered toothbrushes for plaque control and gingival health. *Cochrane Database Syst Rev.* 2010 Dec 8;2010(12):CD004971. doi: 10.1002/14651858.CD004971.pub2. PMID: 21154357; PMCID: PMC8406707.
4. Robinson PG, Deacon SA, Deery C, Heanue M, Walmsley AD, Worthington HV, Glenny AM, Shaw WC. Manual versus powered toothbrushing for oral health. *Cochrane Database Syst Rev.* 2005 Apr 18;(2):CD002281. doi: 10.1002/14651858.CD002281.pub2. Update in: *Cochrane Database Syst Rev.* 2014;6:CD002281. PMID: 15846633.
5. Sälzer S, Slot DE, Van der Weijden FA, Dörfer CE. Efficacy of inter-dental mechanical plaque control in managing gingivitis--a meta-review. *J Clin Periodontol.* 2015;42 Suppl 16:S92-105. doi: 10.1111/jcpe.12363. PMID: 25581718.
6. Valkenburg C, Slot DE, Bakker EW, Van der Weijden FA. Does dentifrice use help to remove plaque? A systematic review. *J Clin Periodontol.* 2016;43:1050-1058. doi: 10.1111/jcpe.12615. Epub 2016 Oct 3. PMID: 27513809.
7. Figuero E, Nóbrega DF, García-Gargallo M, Tenuta LM, Herrera D, Carvalho JC. Mechanical and chemical plaque control in the simultaneous management of gingivitis and caries: a systematic review. *J Clin Periodontol.* 2017;44 Suppl 18:S116-s134. doi: 10.1111/jcpe.12674. PMID: 28266113.
8. Sambunjak D, Nickerson JW, Poklepovic T, et al. Flossing for the management of periodontal diseases and dental caries in adults. *Cochrane Database Syst Rev.* 2011;CD008829. doi:

10.1002/14651858.CD008829.pub2. Update in: *Cochrane Database Syst Rev*. 2019 Apr 23;4:CD008829. PMID: 22161438.

6.2 Non-Surgical Therapy

Questions to be answered:

- What are the limitations of Scaling and Root planning
- How do the tissues heal after non-surgical periodontal therapy?
- How long do the effects of non-surgical therapy last?
- What are the microbiological changes that result from non-surgical therapy?
- What is the most appropriate recall maintenance protocol for periodontal patients?

General Considerations/ Anatomical considerations

1. Waerhaug J. The gingival pocket; anatomy, pathology, deepening and elimination. *Odontol Tidskr*. 1952;60:1-186; 170 figures. PMID: 12983016.
2. Zander HA. The Attachment of Calculus to Root Surfaces. *J Periodontol*. 1953;24:16-19. doi: 10.1902/JOP.1953.24.1.16.
3. Wilkinson RF, Maybury JE. Scanning electron microscopy of the root surface following instrumentation. *J Periodontol*. 1973;44:559-563. doi: 10.1902/jop.1973.44.9.559.
4. Aleo JJ, De Renzis FA, Farber PA, Varboncoeur AP. The presence and biologic activity of cementum-bound endotoxin. *J Periodontol*. 1974;45:672-675. doi: 10.1902/jop.1974.45.9.672.
5. Lindhe J, Socransky SS, Nyman S, Haffajee A, Westfelt E. "Critical probing depths" in periodontal therapy. *J Clin Periodontol*. 1982;9:323-336. doi: 10.1111/j.1600-051x.1982.tb02099.x.
6. Lindhe J, Haffajee AD, Socransky SS. Progression of periodontal disease in adult subjects in the absence of periodontal therapy. *J Clin Periodontol*. 1983;10:433-442. doi: 10.1111/j.1600-051x.1983.tb01292.x.
7. Lindhe J, Socransky S, Wennström J. Design of clinical trials of traditional therapies of periodontitis. *J Clin Periodontol*. 1986;13:488-499. doi: 10.1111/j.1600-051x.1986.tb01495.x.
8. Greenwell H, Stovsky DA, Bissada NF. Periodontics in general practice: perspectives on nonsurgical therapy. *J Am Dent Assoc*. 1987;115:591-595. doi: 10.1016/s0002-8177(87)54014-4.
9. Brayer WK, Mellonig JT, Dunlap RM, Marinak KW, Carson RE. Scaling and root planing effectiveness: the effect of root surface access and operator experience. *J Periodontol*. 1989;60:67-72. doi: 10.1902/jop.1989.60.1.67.
10. Fleischer HC, Mellonig JT, Brayer WK, Gray JL, Barnett JD. Scaling and root planing efficacy in multirooted teeth. *J Periodontol*. 1989;60:402-409. doi: 10.1902/jop.1989.60.7.402.
11. Coldiron NB, Yukna RA, Weir J, Caudill RF. A quantitative study of cementum removal with hand curettes. *J Periodontol*. 1990;61:293-299. doi: 10.1902/jop.1990.61.5.293.
12. Badersten A, Nilvénus R, Egelberg J. Scores of plaque, bleeding, suppuration and probing depth to predict probing attachment loss. 5 years of observation following nonsurgical periodontal therapy. *J Clin Periodontol*. 1990;17:102-107. doi: 10.1111/j.1600-051x.1990.tb01070.x.
13. Claffey N, Nylund K, Kiger R, Garrett S, Egelberg J. Diagnostic predictability of scores of plaque, bleeding, suppuration and probing depth for probing attachment loss. 3 1/2 years of observation following initial periodontal therapy. *J Clin Periodontol*. 1990;17:108-114. doi: 10.1111/j.1600-051x.1990.tb01071.x.

14. Ritz L, Hefti AF, Rateitschak KH. An in vitro investigation on the loss of root substance in scaling with various instruments. *J Clin Periodontol.* 1991;18:643-647. doi: 10.1111/j.1600-051x.1991.tb00104.x.
15. Claffey N, Egelberg J. Clinical characteristics of periodontal sites with probing attachment loss following initial periodontal treatment. *J Clin Periodontol.* 1994;21:670-679. doi: 10.1111/j.1600-051x.1994.tb00785.x.
16. Claffey N, Egelberg J. Clinical indicators of probing attachment loss following initial periodontal treatment in advanced periodontitis patients. *J Clin Periodontol.* 1995;22:690-696. doi: 10.1111/j.1600-051x.1995.tb00828.x.
17. Novaes AB Jr., Novaes AB. Compliance with supportive periodontal therapy. Part 1. Risk of non-compliance in the first 5-year period. *J Periodontol.* 1999;70:679-682. doi: 10.1902/jop.1999.70.6.679.
18. Cobb CM. Clinical significance of non-surgical periodontal therapy: an evidence-based perspective of scaling and root planing. *J Clin Periodontol.* 2002;29 Suppl 2:6-16. PMID: 12010523.
19. Miyamoto T, Kumagai T, Jones JA, Van Dyke TE, Nunn ME. Compliance as a prognostic indicator: retrospective study of 505 patients treated and maintained for 15 years. *J Periodontol.* 2006;77:223-232. doi: 10.1902/jop.2006.040349.
20. Trombelli L, Rizzi A, Simonelli A, Scapoli C, Carrieri A, Farina R. Age-related treatment response following non-surgical periodontal therapy. *J Clin Periodontol.* 2010;37:346-352. doi: 10.1111/j.1600-051X.2010.01541.x.

Goals, Technique, Instrumentation

1. Pihlstrom BL, Oliphant TH, McHugh RB. Molar and nonmolar teeth compared over 6 1/2 years following two methods of periodontal therapy. *J Periodontol.* 1984;55:499-504. doi: 10.1902/jop.1984.55.9.499.
2. Badersten A, Nilveus R, Egelberg J. Effect of nonsurgical periodontal therapy. III. Single versus repeated instrumentation. *J Clin Periodontol.* 1984;11:114-124. doi: 10.1111/j.1600-051x.1984.tb00839.x.
3. Becker W, Becker BE, Berg LE. Periodontal treatment without maintenance. A retrospective study in 44 patients. *J Periodontol.* 1984;55:505-509. doi: 10.1902/jop.1984.55.9.505.
4. Isidor F, Karring T, Attström R. The effect of root planing as compared to that of surgical treatment. *J Clin Periodontol.* 1984;11:669-681. doi: 10.1111/j.1600-051x.1984.tb01315.x.
5. Lindhe J, Westfelt E, Nyman S, Socransky SS, Haffajee AD. Long-term effect of surgical/non-surgical treatment of periodontal disease. *J Clin Periodontol.* 1984;11:448-458. doi: 10.1111/j.1600-051x.1984.tb01344.x.
6. Matia JI, Bissada NF, Maybury JE, Ricchetti P. Efficiency of scaling of the molar furcation area with and without surgical access. *Int J Periodontics Restorative Dent.* 1986;6:24-35. PMID: 3542872.
7. Caffesse RG, Sweeney PL, Smith BA. Scaling and root planing with and without periodontal flap surgery. *J Clin Periodontol.* 1986;13:205-210. doi: 10.1111/j.1600-051x.1986.tb01461.x.
8. Ramfjord SP, Caffesse RG, Morrison EC, et al. 4 modalities of periodontal treatment compared over 5 years. *J Clin Periodontol.* 1987;14:445-452. doi: 10.1111/j.1600-051x.1987.tb02249.x.
9. Breininger DR, O'Leary TJ, Blumenshine RV. Comparative effectiveness of ultrasonic and hand scaling for the removal of subgingival plaque and calculus. *J Periodontol.* 1987;58:9-18. doi: 10.1902/jop.1987.58.1.9.
10. Buchanan SA, Robertson PB. Calculus removal by scaling/root planing with and without surgical access. *J Periodontol.* 1987;58:159-163. doi: 10.1902/jop.1987.58.3.159.

11. Nagy RJ, Otomo-Corgel J, Stambaugh R. The effectiveness of scaling and root planing with curets designed for deep pockets. *J Periodontol.* 1992;63:954-959. doi: 10.1902/jop.1992.63.12.954.
12. Quirynen M, Bollen CM, Vandekerckhove BN, Dekeyser C, Papaioannou W, Eyssen H. Full- vs. partial-mouth disinfection in the treatment of periodontal infections: short-term clinical and microbiological observations. *J Dent Res.* 1995;74:1459-1467. doi: 10.1177/00220345950740080501.
13. Oberholzer R, Rateitschak KH. Root cleaning or root smoothing. An in vivo study. *J Clin Periodontol.* 1996;23:326-330. doi: 10.1111/j.1600-051x.1996.tb00553.x.
14. Mongardini C, van Steenberghe D, Dekeyser C, Quirynen M. One stage full- versus partial-mouth disinfection in the treatment of chronic adult or generalized early-onset periodontitis. I. Long-term clinical observations. *J Periodontol.* 1999;70:632-645. doi: 10.1902/jop.1999.70.6.632.
15. Apatzidou DA, Kinane DF. Quadrant root planing versus same-day full-mouth root planing. I. Clinical findings. *J Clin Periodontol.* 2004;31:132-140. doi: 10.1111/j.0303-6979.2004.00461.x.
16. Apatzidou DA, Riggio MP, Kinane DF. Quadrant root planing versus same-day full-mouth root planing. II. Microbiological findings. *J Clin Periodontol.* 2004;31:141-148. doi: 10.1111/j.0303-6979.2004.00462.x.
17. Tomasi C, Wennström JL. Full-mouth treatment vs. the conventional staged approach for periodontal infection control. *Periodontol 2000.* 2009;51:45-62. doi: 10.1111/j.1600-0757.2009.00306.x.
18. Aljateeli M, Koticha T, Bashutski J, et al. Surgical periodontal therapy with and without initial scaling and root planing in the management of chronic periodontitis: a randomized clinical trial. *J Clin Periodontol.* 2014;41:693-700. doi: 10.1111/jcpe.12259.
19. Krishna R, De Stefano JA. Ultrasonic vs. hand instrumentation in periodontal therapy: clinical outcomes. *Periodontol 2000.* 2016;71:113-127. doi: 10.1111/prd.12119.

Outcomes & Maintenance

1. Ramfjord SP, Knowles JW, Nissle RR, Burgett FG, Shick RA. Results following three modalities of periodontal therapy. *J Periodontol.* 1975;46:522-526. doi: 10.1902/jop.1975.46.9.522.
2. Waerhaug J. Healing of the dento-epithelial junction following subgingival plaque control. I. As observed in human biopsy material. *J Periodontol.* 1978;49:1-8. doi: 10.1902/jop.1978.49.1.1.
3. Lindhe J, Westfelt E, Nyman S, Socransky SS, Heijl L, Bratthall G. Healing following surgical/non-surgical treatment of periodontal disease. A clinical study. *J Clin Periodontol.* 1982;9:115-128. doi: 10.1111/j.1600-051x.1982.tb01227.x.
4. Waerhaug J. Healing of the dento-epithelial junction following subgingival plaque control. II: As observed on extracted teeth. *J Periodontol.* 1978;49:119-134. doi: 10.1902/jop.1978.49.3.119.
5. Jones WA, O'Leary TJ. The effectiveness of in vivo root planing in removing bacterial endotoxin from the roots of periodontally involved teeth. *J Periodontol.* 1978;49:337-342. doi: 10.1902/jop.1978.49.7.337.
6. Slots J, Mashimo P, Levine MJ, Genco RJ. Periodontal therapy in humans. I. Microbiological and clinical effects of a single course of periodontal scaling and root planing, and of adjunctive tetracycline therapy. *J Periodontol.* 1979;50:495-509. doi: 10.1902/jop.1979.50.10.495.
7. Knowles J, Burgett F, Morrison E, Nissle R, Ramfjord S. Comparison of results following three modalities of periodontal therapy related to tooth type and initial pocket depth. *J Clin Periodontol.* 1980;7:32-47. doi: 10.1111/j.1600-051x.1980.tb01947.x.

8. Morrison EC, Ramfjord SP, Hill RW. Short-term effects of initial, nonsurgical periodontal treatment (hygienic phase). *J Clin Periodontol.* 1980;7:199-211. doi: 10.1111/j.1600-051x.1980.tb01963.x.
9. Axelsson P, Lindhe J. The significance of maintenance care in the treatment of periodontal disease. *J Clin Periodontol.* 1981;8:281-294. doi: 10.1111/j.1600-051x.1981.tb02039.x.
10. Axelsson P, Lindhe J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. Results after 6 years. *J Clin Periodontol.* 1981;8:239-248. doi: 10.1111/j.1600-051x.1981.tb02035.x.
11. Badersten A, Nilveus R, Egelberg J. Effect of nonsurgical periodontal therapy. I. Moderately advanced periodontitis. *J Clin Periodontol.* 1981;8:57-72. doi: 10.1111/j.1600-051x.1981.tb02024.x.
12. Rabbani GM, Ash MM, Jr., Caffesse RG. The effectiveness of subgingival scaling and root planing in calculus removal. *J Periodontol.* 1981;52:119-123. doi: 10.1902/jop.1981.52.3.119.
13. Lindhe J, Nyman S. Long-term maintenance of patients treated for advanced periodontal disease. *J Clin Periodontol.* 1984;11:504-514. doi: 10.1111/j.1600-051x.1984.tb00902.x.
14. Wilson TG, Jr., Glover ME, Schoen J, Baus C, Jacobs T. Compliance with maintenance therapy in a private periodontal practice. *J Periodontol.* 1984;55:468-473. doi: 10.1902/jop.1984.55.8.468.
15. Badersten A, Nilveus R, Egelberg J. Effect of nonsurgical periodontal therapy. II. Severely advanced periodontitis. *J Clin Periodontol.* 1984;11:63-76. doi: 10.1111/j.1600-051x.1984.tb01309.x.
16. Westfelt E, Bragd L, Socransky SS, Haffajee AD, Nyman S, Lindhe J. Improved periodontal conditions following therapy. *J Clin Periodontol.* 1985;12:283-293. doi: 10.1111/j.1600-051x.1985.tb02294.x.
17. Badersten A, Niveus R, Egelberg J. 4-year observations of basic periodontal therapy. *J Clin Periodontol.* 1987;14:438-444. doi: 10.1111/j.1600-051x.1987.tb02248.x.
18. Nordland P, Garrett S, Kiger R, Vanooteghem R, Hutchens LH, Egelberg J. The effect of plaque control and root debridement in molar teeth. *J Clin Periodontol.* 1987;14:231-236. doi: 10.1111/j.1600-051x.1987.tb00972.x.
19. Claffey N, Loos B, Gantes B, Martin M, Heins P, Egelberg J. The relative effects of therapy and periodontal disease on loss of probing attachment after root debridement. *J Clin Periodontol.* 1988;15:163-169. doi: 10.1111/j.1600-051x.1988.tb01563.x.
20. Loos B, Nylund K, Claffey N, Egelberg J. Clinical effects of root debridement in molar and non-molar teeth. A 2-year follow-up. *J Clin Periodontol.* 1989;16:498-504. doi: 10.1111/j.1600-051x.1989.tb02326.x.
21. Sherman PR, Hutchens LH, Jr., Jewson LG. The effectiveness of subgingival scaling and root planing. II. Clinical responses related to residual calculus. *J Periodontol.* 1990;61:9-15. doi: 10.1902/jop.1990.61.1.9.
22. Wilson TG, Jr., Hale S, Temple R. The results of efforts to improve compliance with supportive periodontal treatment in a private practice. *J Periodontol.* 1993;64:311-314. doi: 10.1902/jop.1993.64.4.311.
23. Heasman PA, McCracken GI, Steen N. Supportive periodontal care: the effect of periodic subgingival debridement compared with supragingival prophylaxis with respect to clinical outcomes. *J Clin Periodontol.* 2002;29 Suppl 3:163-172; discussion 195-166. doi: 10.1034/j.1600-051x.29.s3.9.x.
24. Axelsson P, Nystrom B, Lindhe J. The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *J Clin Periodontol.* 2004;31:749-757. doi: 10.1111/j.1600-051X.2004.00563.x.
25. Miyamoto T, Kumagai T, Lang MS, Nunn ME. Compliance as a prognostic indicator. II. Impact of patient's compliance to the individual tooth survival. *J Periodontol.* 2010;81:1280-1288. doi: 10.1902/jop.2010.4400039.

26. Ng MC, Ong MM, Lim LP, Koh CG, Chan YH. Tooth loss in compliant and non-compliant periodontally treated patients: 7 years after active periodontal therapy. *J Clin Periodontol.* 2011;38:499-508. doi: 10.1111/j.1600-051X.2011.01708.x.
27. Tan WC, Ong MM, Lang NP. Influence of maintenance care in periodontally susceptible and non-susceptible subjects following implant therapy. *Clin Oral Implants Res.* 2017;28:491-494. doi: 10.1111/clr.12824.
28. Echeverria JJ, Echeverria A, Caffesse RG. Adherence to supportive periodontal treatment. *Periodontol 2000.* 2019;79:200-209. doi: 10.1111/prd.12256.
29. Matuliene G, Pjetursson BE, Salvi GE, et al. Influence of residual pockets on progression of periodontitis and tooth loss: results after 11 years of maintenance. *J Clin Periodontol.* 2008;35:685-695. doi: 10.1111/j.1600-051X.2008.01245.x.

Microbiology

1. Magnusson I, Lindhe J, Yoneyama T, Liljenberg B. Recolonization of a subgingival microbiota following scaling in deep pockets. *J Clin Periodontol.* 1984;11:193-207. doi: 10.1111/j.1600-051x.1984.tb01323.x.
2. Leon LE, Vogel RI. A comparison of the effectiveness of hand scaling and ultrasonic debridement in furcations as evaluated by differential dark-field microscopy. *J Periodontol.* 1987;58:86-94. doi: 10.1902/jop.1987.58.2.86.
3. Leknes KN, Lie T, Wikesjö UM, Bogle GC, Selvig KA. Influence of tooth instrumentation roughness on subgingival microbial colonization. *J Periodontol.* 1994;65:303-308. doi: 10.1902/jop.1994.65.4.303.
4. Haffajee AD, Cugini MA, Dibart S, Smith C, Kent RL, Jr., Socransky SS. The effect of SRP on the clinical and microbiological parameters of periodontal diseases. *J Clin Periodontol.* 1997;24:324-334. doi: 10.1111/j.1600-051x.1997.tb00765.x.
5. Feres M, Gursky LC, Faveri M, Tsuzuki CO, Figueiredo LC. Clinical and microbiological benefits of strict supragingival plaque control as part of the active phase of periodontal therapy. *J Clin Periodontol.* 2009;36:857-867. doi: 10.1111/j.1600-051X.2009.01471.x.

Reviews:

1. Pihlstrom BL, McHugh RB, Oliphant TH, Ortiz-Campos C. Comparison of surgical and nonsurgical treatment of periodontal disease. A review of current studies and additional results after 6 1/2 years. *J Clin Periodontol.* 1983;10:524-541. doi: 10.1111/j.1600-051x.1983.tb02182.x.
2. Lang NP, Löe H. Clinical management of periodontal diseases. *Periodontol 2000.* 1993;2:128-139. doi: 10.1111/j.1600-0757.1993.tb00225.x.
3. Armitage GC. Periodontal diseases: diagnosis. *Ann Periodontol.* 1996;1:37-215. doi: 10.1902/annals.1996.1.1.37.
4. Cobb CM. Non-surgical pocket therapy: mechanical. *Ann Periodontol.* 1996;1:443-490. doi: 10.1902/annals.1996.1.1.443.
5. Greenstein G. Full-mouth therapy versus individual quadrant root planning: a critical commentary. *J Periodontol.* 2002;73:797-812. doi: 10.1902/jop.2002.73.7.797.
6. Laleman I, Cortellini S, De Winter S, et al. Subgingival debridement: end point, methods and how often? *Periodontol 2000.* 2017;75:189-204. doi: 10.1111/prd.12204.

7. Monje A, Catena A, Borgnakke WS. Association between diabetes mellitus/hyperglycaemia and peri-implant diseases: Systematic review and meta-analysis. *J Clin Periodontol*. 2017;44:636-648. doi: 10.1111/jcpe.12724.
8. Lang NP, Salvi GE, Sculean A. Nonsurgical therapy for teeth and implants-When and why? *Periodontol 2000*. 2019;79:15-21. doi: 10.1111/prd.12240.
9. Suvan J, Leira Y, Moreno Sancho FM, Graziani F, Derkx J, Tomasi C. Subgingival instrumentation for treatment of periodontitis. A systematic review. *J Clin Periodontol*. 2020;47 Suppl 22:155-175. doi: 10.1111/jcpe.13245.

6.3 Mechanical Debridement: manual and powered devices

Questions to be answered:

- What are the advantages and disadvantages of the use of powered devices for periodontal therapy?
- What are the differences between the different types of powered scalers used in periodontics?
- Is there an advantage in using air polishing devices during non-surgical periodontal therapy?

1. Gellin RG, Miller MC, Javed T, Engler WO, Mishkin DJ. The effectiveness of the Titan-S sonic scaler versus curettes in the removal of subgingival calculus. A human surgical evaluation. *J Periodontol*. 1986;57:672-680. doi: 10.1902/jop.1986.57.11.672.
2. Breininger DR, O'Leary TJ, Blumenshine RV. Comparative effectiveness of ultrasonic and hand scaling for the removal of subgingival plaque and calculus. *J Periodontol*. 1987;58:9-18. doi: 10.1902/jop.1987.58.1.9.
3. Drisko CH. Root instrumentation. Power-driven versus manual scalers, which one? *Dent Clin North Am*. 1998;42:229-244. PMID: 9597335.
4. Drisko CL, Cochran DL, Blieden T, et al. Position paper: sonic and ultrasonic scalers in periodontics. Research, Science and Therapy Committee of the American Academy of Periodontology. *J Periodontol*. 2000;71:1792-1801. (In May 2007, the Board of Trustees of the American Academy of Periodontology rescinded the paper).
5. Busslinger A, Lampe K, Beuchat M, Lehmann B. A comparative in vitro study of a magnetostrictive and a piezoelectric ultrasonic scaling instrument. *J Clin Periodontol*. 2001;28:642-649. doi: 10.1034/j.1600-051x.2001.028007642.x.
6. Flemmig TF, Arushanov D, Daubert D, Rothen M, Mueller G, Leroux BG. Randomized controlled trial assessing efficacy and safety of glycine powder air polishing in moderate-to-deep periodontal pockets. *J Periodontol*. 2012;83:444-452. doi: 10.1902/jop.2011.110367.

Review:

10. Lang NP, Löe H. Clinical management of periodontal diseases. *Periodontol 2000*. 1993;2:128-139. doi: 10.1111/j.1600-0757.1993.tb00225.x.
11. Arabaci T, Cicek Y, Canakci CF. Sonic and ultrasonic scalers in periodontal treatment: a review. *Int J Dent Hyg*. 2007;5:2-12. doi: 10.1111/j.1601-5037.2007.00217.x.

6.4 Treatment of periodontitis with lasers

Questions to be answered:

- What laser systems have documented effectiveness in the non-surgical treatment of periodontal disease?
- What is the evidence supporting surgical periodontal therapy for different laser types and protocols?
- What are the side effects of lasers applied on bone, soft tissues, and root surfaces?

Er:YAG

1. Schwarz F, Sculean A, Georg T, Reich E. Periodontal treatment with an Er:YAG laser compared to scaling and root planing. A controlled clinical study. *J Periodontol.* 2001 Mar;72(3):361-7. doi: 10.1902/jop.2001.72.3.361. PMID: 11327064.
2. Schwarz F, Sculean A, Berakdar M, Georg T, Reich E, Becker J. Periodontal treatment with an Er:YAG laser or scaling and root planing. A 2-year follow-up split-mouth study. *J Periodontol.* 2003 May;74(5):590-6. doi: 10.1902/jop.2003.74.5.590. PMID: 12816290.
3. Schwarz F, Sculean A, Berakdar M, Georg T, Reich E, Becker J. Clinical evaluation of an Er:YAG laser combined with scaling and root planing for non-surgical periodontal treatment. A controlled, prospective clinical study. *J Clin Periodontol.* 2003 Jan;30(1):26-34. doi: 10.1034/j.1600-051x.2003.300105.x. PMID: 12702108.
4. Sculean A, Schwarz F, Berakdar M, Romanos GE, Arweiler NB, Becker J. Periodontal treatment with an Er:YAG laser compared to ultrasonic instrumentation: a pilot study. *J Periodontol.* 2004 Jul;75(7):966-73. doi: 10.1902/jop.2004.75.7.966. PMID: 15341354.
5. Schwarz F, Sculean A, Rothamel D, Schwenzer K, Georg T, Becker J. Clinical evaluation of an Er:YAG laser for nonsurgical treatment of peri-implantitis: a pilot study. *Clin Oral Implants Res.* 2005 Feb;16(1):44-52. doi: 10.1111/j.1600-0501.2004.01051.x. PMID: 15642030.
6. Tomasi C, Schander K, Dahlén G, Wennström JL. Short-term clinical and microbiologic effects of pocket debridement with an Er:YAG laser during periodontal maintenance. *J Periodontol.* 2006 Jan;77(1):111-8. doi: 10.1902/jop.2006.77.1.111. PMID: 16579711.
7. Schwarz F, Bieling K, Nuesry E, Sculean A, Becker J. Clinical and histological healing pattern of peri-implantitis lesions following non-surgical treatment with an Er:YAG laser. *Lasers Surg Med.* 2006 Aug;38(7):663-71. doi: 10.1002/lsm.20347. PMID: 16634072.
8. Rotundo R, Nieri M, Cairo F, Franceschi D, Mervelt J, Bonaccini D, Esposito M, Pini-Prato G. Lack of adjunctive benefit of Er:YAG laser in non-surgical periodontal treatment: a randomized split-mouth clinical trial. *J Clin Periodontol.* 2010 Jun;37(6):526-33. doi: 10.1111/j.1600-051X.2010.01560.x. PMID: 20507376.
9. Aoki A, Mizutani K, Mikami R, Taniguchi Y, Ohsugi Y, Meinzer W, Izumi Y, Iwata T. Residual periodontal pocket treatment with Er:YAG laser-assisted comprehensive periodontal pocket therapy: a retrospective study. *Clin Oral Investig.* 2022 Jan;26(1):761-771. doi: 10.1007/s00784-021-04054-9. Epub 2021 Jul 19. PMID: 34278521.
10. Aoki A, Mizutani K, Mikami R, Ohsugi Y, Kobayashi H, Akizuki T, Taniguchi Y, Takeuchi Y, Katagiri S, Sasaki Y, Komaki M, Meinzer W, Izumi Y, Iwata T. Er:YAG laser-assisted comprehensive periodontal pocket therapy for residual periodontal pocket treatment: A randomized controlled clinical trial. *J Periodontol.* 2023 Apr 4. doi: 10.1002/JPER.22-0552. Epub ahead of print. PMID: 37015852.

Er,Cr:YSGG

1. Al-Falaki R, Cronshaw M, Parker S. The Adjunctive Use of the Erbium, Chromium: Yttrium Scandium Gallium Garnet Laser in Closed Flap Periodontal Therapy. A Retrospective Cohort Study. *Open Dent J.* 2016 Jun 13;10:298-307. doi: 10.2174/1874210601610010298. PMID: 27350796; PMCID: PMC4906144.
2. Clem D, Heard R, McGuire M, Scheyer ET, Richardson C, Toback G, Gwaltney C, Gunsolley JC. Comparison of Er,Cr:YSGG laser to minimally invasive surgical technique in the treatment of intrabony

defects: Six-month results of a multicenter, randomized, controlled study. *J Periodontol.* 2021 Apr;92(4):496-506. doi: 10.1002/JPER.20-0028. Epub 2020 Jul 30. PMID: 32613664.

3. Klokkevold PR, Damian A, Pham C, Mallya SM, Lux R. Clinical evaluation of Er,Cr:YSGG laser therapy used as an adjunct to non-surgical treatment of periodontitis: Twelve-month results from a pilot study. *J Periodontol.* 2022 Sep;93(9):1314-1324. doi: 10.1002/JPER.21-0443. Epub 2022 Mar 24. PMID: 35239185.

Nd:YAG

1. Harris DM, Gregg RH 2nd, McCarthy DK, Colby LE, Tilt LV. Laser-assisted new attachment procedure in private practice. *Gen Dent.* 2004 Sep-Oct;52(5):396-403. PMID: 15544215.
2. Yukna RA, Carr RL, Evans GH. Histologic evaluation of an Nd:YAG laser-assisted new attachment procedure in humans. *Int J Periodontics Restorative Dent.* 2007 Dec;27(6):577-87. PMID: 18092452.
3. Nevins ML, Camelo M, Schupbach P, Kim SW, Kim DM, Nevins M. Human clinical and histologic evaluation of laser-assisted new attachment procedure. *Int J Periodontics Restorative Dent.* 2012 Oct;32(5):497-507. PMID: 22754897.
4. Nevins M, Kim SW, Camelo M, Martin IS, Kim D, Nevins M. A prospective 9-month human clinical evaluation of Laser-Assisted New Attachment Procedure (LANAP) therapy. *Int J Periodontics Restorative Dent.* 2014 Jan-Feb;34(1):21-7. doi: 10.11607/prd.1848. PMID: 24396837.
5. McCawley TK, McCawley MN, Rams TE. Immediate Effects of Laser-Assisted New Attachment Procedure (LANAP) on Human Periodontitis Microbiota. *J Int Acad Periodontol.* 2018 Oct 1;20(4):163-171. PMID: 31522151.
6. Losin KJ, Yukna R, Powell C, Tippets J, Font K. Evaluation of Different Dental Lasers' Ability to Congeal Pooled Blood: An In Vitro Study. *Int J Periodontics Restorative Dent.* 2020 Jul/Aug;40(4):e147-e154. doi: 10.11607/prd.4773. PMID: 32559038.
7. Yukna RA. Clinical evaluation of Laser-Assisted New Attachment Procedure® (LANAP®) surgical treatment of chronic periodontitis: a retrospective case series of 1-year results in 22 consecutive patients. *J Periodontal Implant Sci.* 2023 Jun;53(3):173-183. doi: 10.5051/jpis.2202580129. Epub 2022 Nov 15. PMID: 36468483; PMCID: PMC10315259.

Reviews:

1. Aoki A, Sasaki KM, Watanabe H, Ishikawa I. Lasers in nonsurgical periodontal therapy. *Periodontol 2000.* 2004;36:59-97. doi: 10.1111/j.1600-0757.2004.03679.x. PMID: 15330944.
2. Schwarz F, Aoki A, Becker J, Sculean A. Laser application in non-surgical periodontal therapy: a systematic review. *J Clin Periodontol.* 2008 Sep;35(8 Suppl):29-44. doi: 10.1111/j.1600-051X.2008.01259.x. PMID: 18724840.
3. Ishikawa I, Aoki A, Takasaki AA, Mizutani K, Sasaki KM, Izumi Y. Application of lasers in periodontics: true innovation or myth? *Periodontol 2000.* 2009;50:90-126. doi: 10.1111/j.1600-0757.2008.00283.x. PMID: 19388956.
4. Cobb CM, Low SB, Coluzzi DJ. Lasers and the treatment of chronic periodontitis. *Dent Clin North Am.* 2010 Jan;54(1):35-53. doi: 10.1016/j.cden.2009.08.007. PMID: 20103471.

5. Aoki A, Mizutani K, Schwarz F, Sculean A, Yukna RA, Takasaki AA, Romanos GE, Taniguchi Y, Sasaki KM, Zeredo JL, Koshy G, Coluzzi DJ, White JM, Abiko Y, Ishikawa I, Izumi Y. Periodontal and peri-implant wound healing following laser therapy. *Periodontol 2000*. 2015 Jun;68(1):217-69. doi: 10.1111/prd.12080. PMID: 25867988.

7. Systemic and Local Adjunctive Therapy & Chemotherapeutics

7.1 Systemic Antibiotics & Host Modulators

Questions to be answered:

- What antibiotics have evidence of benefit in the management of patients with periodontitis?
- What are the indications for the systemic use of antibiotics in periodontal patients?
- What is the impact of host modulation therapy on the progression of periodontitis?

1. Listgarten MA, Lindhe J, Hellden L. Effect of tetracycline and/or scaling on human periodontal disease. Clinical, microbiological, and histological observations. *J Clin Periodontol* 1978;5:246-271. doi: 10.1111/j.1600-051x.1978.tb01918.x.
2. Loesche WJ. Clinical and microbiological aspects of chemotherapeutic agents used according to the specific plaque hypothesis. *J Dent Res* 1979;58:2404-2412. doi: 10.1177/00220345790580120905.
3. Gordon JM, Walker CB, Murphy JC, Goodson JM, Socransky SS. Tetracycline: levels achievable in gingival crevice fluid and in vitro effect on subgingival organisms. Part I. Concentrations in crevicular fluid after repeated doses. *J Periodontol* 1981;52:609-612. doi: 10.1902/jop.1981.52.10.609.
4. Walker CB, Gordon JM, McQuilkin SJ, Niebloom TA, Socransky SS. Tetracycline: levels of achievable in gingival crevice fluid and in vitro effect on subgingival organisms. Part II. Susceptibilities of periodontal bacteria. *J Periodontol* 1981;52:613-616. doi: 10.1902/jop.1981.52.10.613.
5. Kornman KS, Karl EH. The effect of long-term low-dose tetracycline therapy on the subgingival microflora in refractory adult periodontitis. *J Periodontol* 1982;53:604-610. doi: 10.1902/jop.1982.53.10.604.
6. Lindhe J, Liljenberg B, Adielsson B. Effect of long-term tetracycline therapy on human periodontal disease. *J Clin Periodontol* 1983;10:590-601. doi: 10.1111/j.1600-051x.1983.tb01297.x.
7. Mitchell DA. Metronidazole: its use in clinical dentistry. *J Clin Periodontol* 1984;11:145-158. doi: 10.1111/j.1600-051x.1984.tb01318.x.
8. van Winkelhoff AJ, Rodenburg JP, Goené RJ, Abbas F, Winkel EG, de Graaff J. Metronidazole plus amoxicillin in the treatment of Actinobacillus actinomycetemcomitans associated periodontitis. *J Clin Periodontol* 1989;16:128-131. doi: 10.1111/j.1600-051x.1989.tb01626.x.
9. Söder PO, Frithiof L, Wikner S, et al. The effect of systemic metronidazole after non-surgical treatment in moderate and advanced periodontitis in young adults. *J Periodontol* 1990;61:281-288. doi: 10.1902/jop.1990.61.5.281.
10. van Winkelhoff AJ, Tijhof CJ, de Graaff J. Microbiological and clinical results of metronidazole plus amoxicillin therapy in Actinobacillus actinomycetemcomitans-associated periodontitis. *J Periodontol* 1992;63:52-57. doi: 10.1902/jop.1992.63.1.52.
11. Christersson LA, Zambon JJ. Suppression of subgingival Actinobacillus actinomycetemcomitans in localized juvenile periodontitis by systemic tetracycline. *J Clin Periodontol* 1993;20:395-401. doi: 10.1111/j.1600-051x.1993.tb00379.x.
12. Collins JG, Offenbacher S, Arnold RR. Effects of a combination therapy to eliminate Porphyromonas gingivalis in refractory periodontitis. *J Periodontol* 1993;64:998-1007. doi: 10.1902/jop.1993.64.10.998.

13. Caton JG, Ciancio SG, Blieden TM, et al. Treatment with subantimicrobial dose doxycycline improves the efficacy of scaling and root planing in patients with adult periodontitis. *J Periodontol* 2000;71:521-532. doi: 10.1902/jop.2000.71.4.521.
14. Feres M, Haffajee AD, Allard K, Som S, Socransky SS. Change in subgingival microbial profiles in adult periodontitis subjects receiving either systemically-administered amoxicillin or metronidazole. *J Clin Periodontol* 2001;28:597-609. doi: 10.1034/j.1600-051x.2001.028007597.x.
15. Purucker P, Mertes H, Goodson JM, Bernimoulin JP. Local versus systemic adjunctive antibiotic therapy in 28 patients with generalized aggressive periodontitis. *J Periodontol* 2001;72:1241-1245. doi: 10.1902/jop.2000.72.9.1241.
16. Lavda M, Clausnitzer CE, Walters JD. Distribution of systemic ciprofloxacin and doxycycline to gingiva and gingival crevicular fluid. *J Periodontol* 2004;75:1663-1667. doi: 10.1902/jop.2004.75.12.1663.
17. Ehmke B, Moter A, Beikler T, Milian E, Flemmig TF. Adjunctive antimicrobial therapy of periodontitis: long-term effects on disease progression and oral colonization. *J Periodontol* 2005;76:749-759. doi: 10.1902/jop.2005.76.5.749.
18. Guerrero A, Griffiths GS, Nibali L, et al. Adjunctive benefits of systemic amoxicillin and metronidazole in non-surgical treatment of generalized aggressive periodontitis: a randomized placebo-controlled clinical trial. *J Clin Periodontol* 2005;32:1096-1107. doi: 10.1111/j.1600-051X.2005.00814.x.
19. Haffajee AD, Torresay G, Socransky SS. Clinical changes following four different periodontal therapies for the treatment of chronic periodontitis: 1-year results. *J Clin Periodontol* 2007;34:243-253. doi: 10.1111/j.1600-051X.2006.01040.x.
20. Matarazzo F, Figueiredo LC, Cruz SE, Faveri M, Feres M. Clinical and microbiological benefits of systemic metronidazole and amoxicillin in the treatment of smokers with chronic periodontitis: a randomized placebo-controlled study. *J Clin Periodontol* 2008;35:885-896. doi: 10.1111/j.1600-051X.2008.01304.x.
21. Novak MJ, Dawson DR, 3rd, Magnusson I, et al. Combining host modulation and topical antimicrobial therapy in the management of moderate to severe periodontitis: a randomized multicenter trial. *J Periodontol* 2008;79:33-41. doi: 10.1902/jop.2008.070237.
22. Haas AN, de Castro GD, Moreno T, et al. Azithromycin as an adjunctive treatment of aggressive periodontitis: 12-months randomized clinical trial. *J Clin Periodontol* 2008;35:696-704. doi: 10.1111/j.1600-051X.2008.01254.x.
23. Herrera D, Alonso B, Leon R, Roldan S, Sanz M. Antimicrobial therapy in periodontitis: the use of systemic antimicrobials against the subgingival biofilm. *J Clin Periodontol* 2008;35:45-66. doi: 10.1111/j.1600-051X.2008.01260.x.
24. Griffiths GS, Ayob R, Guerrero A, et al. Amoxicillin and metronidazole as an adjunctive treatment in generalized aggressive periodontitis at initial therapy or re-treatment: a randomized controlled clinical trial. *J Clin Periodontol* 2011;38:43-49. doi: 10.1111/j.1600-051X.2010.01632.x.
25. Sampaio E, Rocha M, Figueiredo LC, et al. Clinical and microbiological effects of azithromycin in the treatment of generalized chronic periodontitis: a randomized placebo-controlled clinical trial. *J Clin Periodontol* 2011;38:838-846. doi: 10.1111/j.1600-051X.2011.01766.x.
26. Marsh PD, Moter A, Devine DA. Dental plaque biofilms: communities, conflict and control. *Periodontol 2000* 2011;55:16-35. doi: 10.1111/j.1600-0757.2009.00339.x.
27. Mombelli A, Cionca N, Almaglouth A. Does adjunctive antimicrobial therapy reduce the perceived need for periodontal surgery? *Periodontol 2000* 2011;55:205-216. doi: 10.1111/j.1600-0757.2010.00356.x.

28. Kapoor A, Malhotra R, Grover V, Grover D. Systemic antibiotic therapy in periodontics. *Dent Res J (Isfahan)* 2012;9:505-515. doi: 10.4103/1735-3327.104866.
29. Goodson JM, Haffajee AD, Socransky SS, et al. Control of periodontal infections: a randomized controlled trial I. The primary outcome attachment gain and pocket depth reduction at treated sites. *J Clin Periodontol* 2012;39:526-536. doi: 10.1111/j.1600-051X.2012.01870.x
30. Teles R, Teles F, Frias-Lopez J, Paster B, Haffajee A. Lessons learned and unlearned in periodontal microbiology. *Periodontol 2000* 2013;62:95-162. doi: 10.1111/prd.12010.
31. Mombelli A, Almaghlouth A, Cionca N, Courvoisier DS, Giannopoulou C. Differential benefits of amoxicillin-metronidazole in different phases of periodontal therapy in a randomized controlled crossover clinical trial. *J Periodontol* 2015;86:367-375. doi: 10.1902/jop.2014.140478.
32. Feres M, Figueiredo LC, Soares GM, Faveri M. Systemic antibiotics in the treatment of periodontitis. *Periodontol 2000* 2015;67:131-186. doi: 10.1111/prd.12075.
33. Cosgarea R, Juncar R, Heumann C, et al. Non-surgical periodontal treatment in conjunction with 3 or 7 days systemic administration of amoxicillin and metronidazole in severe chronic periodontitis patients. A placebo-controlled randomized clinical study. *J Clin Periodontol* 2016;43:767-777. doi: 10.1111/jcpe.12559.
34. Van der Velden U. What exactly distinguishes aggressive from chronic periodontitis: is it mainly a difference in the degree of bacterial invasiveness? *Periodontol 2000* 2017;75:24-44. doi: 10.1111/prd.12202.
35. Cosgarea R, Heumann C, Juncar R, et al. One year results of a randomized controlled clinical study evaluating the effects of non-surgical periodontal therapy of chronic periodontitis in conjunction with three or seven days systemic administration of amoxicillin/metronidazole. *PLoS One* 2017;12:e0179592. doi: 10.1371/journal.pone.0179592.
36. Borges I, Faveri M, Figueiredo LC, et al. Different antibiotic protocols in the treatment of severe chronic periodontitis: A 1-year randomized trial. *J Clin Periodontol* 2017;44:822-832. doi: 10.1111/jcpe.12721.
37. Jakubovics NS, Goodman SD, Mashburn-Warren L, Stafford GP, Cieplik F. The dental plaque biofilm matrix. *Periodontol 2000* 2021;86:32-56. doi: 10.1111/prd.12361.
38. Abusleme L, Hoare A, Hong BY, Diaz PI. Microbial signatures of health, gingivitis, and periodontitis. *Periodontol 2000* 2021;86:57-78. doi: 10.1111/prd.12362.

Reviews:

39. Gordon JM, Walker CB. Current Status of Systemic Antibiotic Usage in Destructive Periodontal Disease. *Journal of Periodontology* 1993;64:760-771. doi: 10.1902/jop.1993.64.8s.760.
40. Goodson JM. Antimicrobial strategies for treatment of periodontal diseases. *Periodontol 2000* 1994;5:142-168. doi: 10.1111/j.1600-0757.1994.tb00022.x.
41. Slots J, Ting M. Systemic antibiotics in the treatment of periodontal disease. *Periodontol 2000* 2002;28:106-176. doi: 10.1034/j.1600-0757.2002.280106.x.
42. Haffajee AD, Socransky SS, Gunsolley JC. Systemic anti-infective periodontal therapy. A systematic review. *Ann Periodontol* 2003;8:115-181. doi: 10.1902/annals.2003.8.1.115.
43. Reddy MS, Geurs NC, Gunsolley JC. Periodontal host modulation with antiproteinase, anti-inflammatory, and bone-sparing agents. A systematic review. *Ann Periodontol* 2003;8:12-37. doi: 10.1902/annals.2003.8.1.12.

44. Position Paper: Systemic Antibiotics in Periodontics. *Journal of Periodontology* 2004;75:1553-1565. doi: 10.1902/jop.2004.75.11.1553.
45. Sgolastra F, Petrucci A, Gatto R, Monaco A. Effectiveness of systemic amoxicillin/metronidazole as an adjunctive therapy to full-mouth scaling and root planing in the treatment of aggressive periodontitis: a systematic review and meta-analysis. *J Periodontol* 2012;83:731-743. doi: 10.1902/jop.2011.110432.
46. Zandbergen D, Slot DE, Cobb CM, Van der Weijden FA. The clinical effect of scaling and root planing and the concomitant administration of systemic amoxicillin and metronidazole: a systematic review. *J Periodontol* 2013;84:332-351. doi: 10.1902/jop.2012.120040.
47. Rabelo CC, Feres M, Goncalves C, et al. Systemic antibiotics in the treatment of aggressive periodontitis. A systematic review and a Bayesian Network meta-analysis. *J Clin Periodontol* 2015;42:647-657. doi: 10.1111/jcpe.12427.
48. Chambrone L, Vargas M, Arboleda S, et al. Efficacy of Local and Systemic Antimicrobials in the Non-Surgical Treatment of Smokers With Chronic Periodontitis: A Systematic Review. *J Periodontol* 2016;87:1320-1332. doi: 10.1902/jop.2016.160268.
49. Teughels W, Feres M, Oud V, Martin C, Matesanz P, Herrera D. Adjunctive effect of systemic antimicrobials in periodontitis therapy: A systematic review and meta-analysis. *J Clin Periodontol* 2020;47 Suppl 22:257-281. doi: 10.1111/jcpe.13264.

7.2 Local agents: chlorhexidine chip, tetracycline fiber, minocycline, doxycycline

Questions to be answered:

- What are the indications for the different local delivery agents used in periodontal patients?
- What is the evidence of the effectiveness of the various local delivery agents?
- Do local delivery agents provide additional therapeutic benefit when combined with Scaling and Root Planing?

Chlorhexidine Chip

1. Stabholz A, Sela MN, Friedman M, Golomb G, Soskolne A. Clinical and microbiological effects of sustained release chlorhexidine in periodontal pockets. *J Clin Periodontol* 1986;13:783-788. doi: 10.1111/j.1600-051x.1986.tb00882.x.
2. Steinberg D, Friedman M, Soskolne A, Sela MN. A new degradable controlled release device for treatment of periodontal disease: in vitro release study. *J Periodontol* 1990;61:393-398. doi: 10.1902/jop.1990.61.7.393.
3. Soskolne WA, Heasman PA, Stabholz A, et al. Sustained local delivery of chlorhexidine in the treatment of periodontitis: a multi-center study. *J Periodontol* 1997;68:32-38. doi: 10.1902/jop.1997.68.1.32.
4. Jeffcoat MK, Bray KS, Ciancio SG, Dentino AR, Fine DH, Gordon JM, Gunsolley JC, Killoy WJ, Lowenguth RA, Magnusson NI, Offenbacher S, Palcanis KG, Proskin HM, Finkelman RD, Flashner M. Adjunctive use of a subgingival controlled-release chlorhexidine chip reduces probing depth and improves attachment level compared with scaling and root planing alone. *J Periodontol*. 1998 Sep;69(9):989-97. doi: 10.1902/jop.1998.69.9.989. PMID: 9776027.
5. Heasman PA, Heasman L, Stacey F, McCracken GI. Local delivery of chlorhexidine gluconate (PerioChip) in periodontal maintenance patients. *J Clin Periodontol*. 2001 Jan;28(1):90-5. doi: 10.1034/j.1600-051x.2001.280114.x. PMID: 11142674.
6. Azmak N, Atilla G, Luoto H, Sorsa T. The effect of subgingival controlled-release delivery of chlorhexidine chip on clinical parameters and matrix metalloproteinase-8 levels in gingival crevicular fluid. *J Periodontol*. 2002 Jun;73(6):608-15. doi: 10.1902/jop.2002.73.6.608. PMID: 12083533.

7. Cosyn J, Wyn I. A systematic review on the effects of the chlorhexidine chip when used as an adjunct to scaling and root planing in the treatment of chronic periodontitis. *J Periodontol* 2006;77:257-264. doi: 10.1902/jop.2006.050216.
8. Carvalho J, Novak MJ, Mota LF. Evaluation of the effect of subgingival placement of chlorhexidine chips as an adjunct to scaling and root planing. *J Periodontol.* 2007 Jun;78(6):997-1001. doi: 10.1902/jop.2007.060122. PMID: 17539711.

Tetracycline Fiber

1. Lindhe J, Heijl L, Goodson JM, Socransky SS. Local tetracycline delivery using hollow fiber devices in periodontal therapy. *J Clin Periodontol* 1979;6:141-149. doi: 10.1111/j.1600-051x.1979.tb02193.x.
2. Goodson JM, Haffajee A, Socransky SS. Periodontal therapy by local delivery of tetracycline. *J Clin Periodontol.* 1979 Apr;6(2):83-92. doi: 10.1111/j.1600-051x.1979.tb02186.x. PMID: 379050.
3. Goodson JM, Hogan PE, Dunham SL. Clinical Responses Following Periodontal Treatment by Local Drug Delivery. *J Periodontol* 1985;56:81-87. doi: 10.1902/jop.1985.56.11s.81.
4. Baker PJ, Evans RT, Coburn RA, Genco RJ. Tetracycline and its derivatives strongly bind to and are released from the tooth surface in active form. *J Periodontol* 1983;54:580-585. doi: 10.1902/jop.1983.54.10.580.
5. Minabe M, Takeuchi K, Tomomatsu E, Hori T, Umemoto T. Clinical effects of local application of collagen film-immobilized tetracycline. *J Clin Periodontol* 1989;16:291-294. doi: 10.1111/j.1600-051x.1989.tb01657.x.
6. Tonetti M, Cugini MA, Goodson JM. Zero-order delivery with periodontal placement of tetracycline-loaded ethylene vinyl acetate fibers. *J Periodontal Res* 1990;25:243-249. doi: 10.1111/j.1600-0765.1990.tb00911.x.
7. Heijl L, Dahlen G, Sundin Y, Wenander A, Goodson JM. A 4-quadrant comparative study of periodontal treatment using tetracycline-containing drug delivery fibers and scaling. *J Clin Periodontol* 1991;18:111-116. doi: 10.1111/j.1600-051x.1991.tb01699.x.
8. Minabe M, Takeuchi K, Nishimura T, Hori T, Umemoto T. Therapeutic effects of combined treatment using tetracycline-immobilized collagen film and root planing in periodontal furcation pockets. *J Clin Periodontol* 1991;18:287-290. doi: 10.1111/j.1600-051x.1991.tb00430.x.
9. Ciancio SG, Cobb CM, Leung M. Tissue concentration and localization of tetracycline following site-specific tetracycline fiber therapy. *J Periodontol* 1992;63:849-853. doi: 10.1902/jop.1992.63.10.849.
10. Morrison SL, Cobb CM, Kazakos GM, Killoy WJ. Root surface characteristics associated with subgingival placement of monolithic tetracycline-impregnated fibers. *J Periodontol* 1992;63:137-143. doi: 10.1902/jop.1992.63.2.137.
11. Rapley JW, Cobb CM, Killoy WJ, Williams DR. Serum Levels of Tetracycline During Treatment With Tetracycline-Containing Fibers. *J Periodontol* 1992;63:817-820. doi: 10.1902/jop.1992.63.10.817.
12. Stabholz A, Kettering J, Aprecio R, Zimmerman G, Baker PJ, Wiksjö UM. Retention of antimicrobial activity by human root surfaces after in situ subgingival irrigation with tetracycline HCl or chlorhexidine. *J Periodontol* 1993;64:137-141. doi: 10.1902/jop.1993.64.2.137.
13. Jeong SN, Han SB, Lee SW, Magnusson I. Effects of tetracycline-containing gel and a mixture of tetracycline and citric acid-containing gel on non-surgical periodontal therapy. *J Periodontol* 1994;65:840-847. doi: 10.1902/jop.1994.65.9.840.

14. Newman MG, Kornman KS, Doherty FM. A 6-month multi-center evaluation of adjunctive tetracycline fiber therapy used in conjunction with scaling and root planing in maintenance patients: clinical results. *J Periodontol* 1994;65:685-691. doi: 10.1902/jop.1994.65.7.685.
15. Unsal E, Akkaya M, Walsh TF. Influence of a single application of subgingival chlorhexidine gel or tetracycline paste on the clinical parameters of adult periodontitis patients. *J Clin Periodontol* 1994;21:351-355. doi: 10.1111/j.1600-051x.1994.tb00725.x.
16. Drisko CL, Cobb CM, Killoy WJ, et al. Evaluation of periodontal treatments using controlled-release tetracycline fibers: clinical response. *J Periodontol* 1995;66:692-699. doi: 10.1902/jop.1995.66.8.692.
17. Lowenguth RA, Chin I, Caton JG, et al. Evaluation of periodontal treatments using controlled-release tetracycline fibers: microbiological response. *J Periodontol* 1995;66:700-707. doi: 10.1902/jop.1995.66.8.700.
18. Wilson TG, Jr., McGuire MK, Greenstein G, Nunn M. Tetracycline fibers plus scaling and root planing versus scaling and root planing alone: similar results after 5 years. *J Periodontol* 1997;68:1029-1032. doi: 10.1902/jop.1997.68.11.1029.

Minocycline

1. Preus HR, Lassen J, Aass AM, Ciancio SG. Bacterial resistance following subgingival and systemic administration of minocycline. *J Clin Periodontol.* 1995;22:380-384. doi: 10.1111/j.1600-051x.1995.tb00164.x.
2. Timmerman MF, van der Weijden GA, van Steenbergen TJ, Mantel MS, de Graaff J, van der Velden U. Evaluation of the long-term efficacy and safety of locally-applied minocycline in adult periodontitis patients. *J Clin Periodontol.* 1996;23:707-716. doi: 10.1111/j.1600-051x.1996.tb00599.x.
3. Radvar M, Pourtaghi N, Kinane DF. Comparison of 3 periodontal local antibiotic therapies in persistent periodontal pockets. *J Periodontol.* 1996;67:860-865. doi: 10.1902/jop.1996.67.9.860.
4. Kinane DF, Radvar M. The effect of smoking on mechanical and antimicrobial periodontal therapy. *J Periodontol.* 1997;68:467-472. doi: 10.1902/jop.1997.68.5.467.
5. Kinane DF, Radvar M. A six-month comparison of three periodontal local antimicrobial therapies in persistent periodontal pockets. *J Periodontol.* 1999;70:1-7. doi: 10.1902/jop.1999.70.1.1.
6. Williams RC, Paquette DW, Offenbacher S, Adams DF, Armitage GC, Bray K, Caton J, Cochran DL, Drisko CH, Fiorellini JP, Giannobile WV, Grossi S, Guerrero DM, Johnson GK, Lamster IB, Magnusson I, Oringer RJ, Persson GR, Van Dyke TE, Wolff LF, Santucci EA, Rodda BE, Lessem J. Treatment of periodontitis by local administration of minocycline microspheres: a controlled trial. *J Periodontol.* 2001 Nov;72(11):1535-1544. doi: 10.1902/jop.2001.72.11.1535. PMID: 11759865.
7. Oringer RJ, Al-Shammari KF, Aldredge WA, et al. Effect of locally delivered minocycline microspheres on markers of bone resorption. *J Periodontol.* 2002;73:835-842. doi: 10.1902/jop.2002.73.8.835.
8. Persson GR, Salvi GE, Heitz-Mayfield LJ, Lang NP. Antimicrobial therapy using a local drug delivery system (Arestin) in the treatment of peri-implantitis. I: Microbiological outcomes. *Clin Oral Implants Res.* 2006;17:386-393. doi: 10.1111/j.1600-0501.2006.01269.x.
9. Cortelli JR, Querido SM, Aquino DR, Ricardo LH, Pallos D. Longitudinal clinical evaluation of adjunct minocycline in the treatment of chronic periodontitis. *J Periodontol.* 2006 Feb;77(2):161-166. doi: 10.1902/jop.2006.040409. PMID: 16460239.
10. Goodson JM, Gunsolley JC, Grossi SG, et al. Minocycline HCl microspheres reduce red-complex bacteria in periodontal disease therapy. *J Periodontol.* 2007;78:1568-1579. doi: 10.1902/jop.2007.060488.

11. Killeen AC, Harn JA, Erickson LM, Yu F, Reinhardt RA. Local Minocycline Effect on Inflammation and Clinical Attachment During Periodontal Maintenance: Randomized Clinical Trial. *J Periodontol*. 2016 Oct;87(10):1149-1157. doi: 10.1902/jop.2016.150551. Epub 2016 Jun 5. PMID: 27263325.

Doxycycline

1. Drisko CH. The use of locally delivered doxycycline in the treatment of periodontitis. Clinical results. *J Clin Periodontol*. 1998;25:947-952; discussion 978-949. doi: 10.1111/j.1600-051x.1998.tb02396.x.
2. Stoller NH, Johnson LR, Trapnell S, Harrold CQ, Garrett S. The pharmacokinetic profile of a biodegradable controlled-release delivery system containing doxycycline compared to systemically delivered doxycycline in gingival crevicular fluid, saliva, and serum. *J Periodontol*. 1998;69:1085-1091. doi: 10.1902/jop.1998.69.10.1085.
3. Garrett S, Johnson L, Drisko CH, et al. Two multi-center studies evaluating locally delivered doxycycline hydralate, placebo control, oral hygiene, and scaling and root planing in the treatment of periodontitis. *J Periodontol*. 1999;70:490-503. doi: 10.1902/jop.1999.70.5.490.
4. Johnson LR, Stoller NH, Polson A, Harrold CQ, Ryder M, Garrett S. The effects of subgingival calculus on the clinical outcomes of locally-delivered controlled-release doxycycline compared to scaling and root planing. *J Clin Periodontol*. 2002 Feb;29(2):87-91. doi: 10.1034/j.1600-051x.2002.290201.x. PMID: 11895536.
5. Bogren A, Teles RP, Torresyap G, Haffajee AD, Socransky SS, Wennström JL. Locally delivered doxycycline during supportive periodontal therapy: a 3-year study. *J Periodontol*. 2008 May;79(5):827-835. doi: 10.1902/jop.2008.070515. PMID: 18454661.
6. Tomasi C, Wennström JL. Locally delivered doxycycline improves the healing following non-surgical periodontal therapy in smokers. *J Clin Periodontol*. 2004 Aug;31(8):589-595. doi: 10.1111/j.1600-051X.2004.00524.x. PMID: 15257733.
7. Tomasi C, Wennström JL. Locally delivered doxycycline as an adjunct to mechanical debridement at retreatment of periodontal pockets: outcome at furcation sites. *J Periodontol*. 2011 Feb;82(2):210-218. doi: 10.1902/jop.2010.100308. Epub 2010 Sep 10. PMID: 20831368.

Metronidazole:

1. Golomb G, Friedman M, Soskolne A, Stabholz A, Sela MN. Sustained release device containing metronidazole for periodontal use. *J Dent Res*. 1984;63:1149-1153. doi: 10.1177/00220345840630091101.
2. Linden GJ, Newman HN. The effects of subgingival irrigation with low dosage metronidazole on periodontal inflammation. *J Clin Periodontol*. 1991;18:177-181. doi: 10.1111/j.1600-051x.1991.tb01130.x.
3. Ainamo J, Lie T, Ellingsen BH, et al. Clinical responses to subgingival application of a metronidazole 25% gel compared to the effect of subgingival scaling in adult periodontitis. *J Clin Periodontol*. 1992;19:723-729. doi: 10.1111/j.1600-051x.1992.tb02535.x.
4. Norling T, Lading P, Engström S, Larsson K, Krog N, Nissen SS. Formulation of a drug delivery system based on a mixture of monoglycerides and triglycerides for use in the treatment of periodontal disease. *J Clin Periodontol*. 1992;19:687-692. doi: 10.1111/j.1600-051x.1992.tb02529.x.
5. Stelzel M, Florès-de-Jacoby L. Topical metronidazole application compared with subgingival scaling. A clinical and microbiological study on recall patients. *J Clin Periodontol*. 1996;23:24-29. doi: 10.1111/j.1600-051x.1996.tb00500.x.

6. Noyan U, Yilmaz S, Kuru B, Kadir T, Acar O, Buget E. A clinical and microbiological evaluation of systemic and local metronidazole delivery in adult periodontitis patients. *J Clin Periodontol.* 1997;24:158-165. doi: 10.1111/j.1600-051x.1997.tb00485.x.
7. Rudhart A, Purucker P, Kage A, Hopfenmuller W, Bernimoulin JP. Local metronidazole application in maintenance patients. Clinical and microbiological evaluation. *J Periodontol.* 1998;69:1148-1154. doi: 10.1902/jop.1998.69.10.1148.

Reviews:

1. Ingman T, Sorsa T, Suomalainen K, et al. Tetracycline inhibition and the cellular source of collagenase in gingival crevicular fluid in different periodontal diseases. *J Periodontol.* 1993;64:82-88. doi: 10.1902/jop.1993.64.2.82.
2. Shiloah J, Hovious LA. The role of subgingival irrigations in the treatment of periodontitis. *J Periodontol.* 1993;64:835-843. doi: 10.1902/jop.1993.64.9.835.
3. Rams TE, Slots J. Local delivery of antimicrobial agents in the periodontal pocket. *Periodontol 2000.* 1996;10:139-159. doi: 10.1111/j.1600-0757.1996.tb00072.x.
4. Position Paper: The Role of Controlled Drug Delivery for Periodontitis. *J Periodontol.* 2000;71:125-140. doi: 10.1902/jop.2000.71.1.125.
5. Killoy WJ. The clinical significance of local chemotherapies. *J Clin Periodontol.* 2002;29 Suppl 2:22-29. PMID: 12010521
6. Hanes PJ, Purvis JP. Local anti-infective therapy: pharmacological agents. A systematic review. *Ann Periodontol.* 2003;8:79-98. doi: 10.1902/annals.2003.8.1.79.
7. Greenstein G. Local drug delivery in the treatment of periodontal diseases: assessing the clinical significance of the results. *J Periodontol.* 2006 Apr;77(4):565-78. doi: 10.1902/jop.2006.050140. PMID: 16584336.
8. American Academy of Periodontology Statement on Local Delivery of Sustained or Controlled Release Antimicrobials as Adjunctive Therapy in the Treatment of Periodontitis. *J Periodontol.* 2006;77:1458. doi: 10.1902/jop.2006.068001.
9. Van Strydonck DA, Slot DE, Van der Velden U, Van der Weijden F. Effect of a chlorhexidine mouthrinse on plaque, gingival inflammation and staining in gingivitis patients: a systematic review. *J Clin Periodontol.* 2012;39:1042-1055. doi: 10.1111/j.1600-051X.2012.01883.x.
10. Tracy SL, Abt E, et al. Systematic review and meta-analysis on the nonsurgical treatment of chronic periodontitis by means of scaling and root planing with or without adjuncts. *J Am Dent Assoc.* 2015;146:508-524.e505. doi: 10.1016/j.adaj.2015.01.028.
11. Jepsen K, Jepsen S. Antibiotics/antimicrobials: systemic and local administration in the therapy of mild to moderately advanced periodontitis. *Periodontol 2000.* 2016;71:82-112. doi: 10.1111/prd.12121.
12. Herrera D, Matesanz P, Martin C, Oud V, Feres M, Teughels W. Adjunctive effect of locally delivered antimicrobials in periodontitis therapy: A systematic review and meta-analysis. *J Clin Periodontol.* 2020;47 Suppl 22:239-256. doi: 10.1111/jcpe.13230.
13. Steinberg D, Friedman M. Sustained-release delivery of antimicrobial drugs for the treatment of periodontal diseases: Fantasy or already reality? *Periodontol 2000.* 2020;84:176-187. doi: 10.1111/prd.12341.

8.1 Occlusal Traumatism: history, human and animal studies

Questions to be answered:

- What is the role of occlusal traumatism in the progression of periodontal disease?
- What is the impact of occlusal adjustment on the periodontal clinical parameters?
- What are the results of the research in the different animal models?

1. Glickman I. Inflammation and Trauma from Occlusion, Co-Destructive Factors in Chronic Periodontal Disease. *J Periodontol.* 1963;34:5-10. doi: 10.1902/JOP.1963.34.1.5
2. Glickman I, Smulow JB. Effect of excessive occlusal forces upon the pathway of gingival inflammation in humans. *J Periodontol (1930)*. 1965;36:141-147. doi: 10.1902/jop.1965.36.2.141.
3. Yuodelis RA, Mann WV Jr. The prevalence and possible role of nonworking contacts in periodontal disease. *Periodontics.* 1965;3:219-223. PMID: 5212904
4. Ramfjord SP. The Periodontal Disease Index (PDI). *J Periodontol.* 1967;38(Suppl):602-610. doi: 10.1902/jop.1967.38.6.602.
5. Glickman I, Smulow JB. Adaptive alterations in the periodontium of the rhesus monkey in chronic trauma from occlusion. *J Periodontol.* 1968;39:101-105. doi: 10.1902/jop.1968.39.2.101.
6. Pameijer JH, Glickman I, Roeber FW. Intraoral occlusal telemetry. 3. Tooth contacts in chewing, swallowing and bruxism. *J Periodontol.* 1969;40:253-258. doi: 10.1902/jop.1969.40.5.253.
7. Pihlstrom BL, Ramfjord SP. Periodontal effect of nonfunction in monkeys. *J Periodontol.* 1971;42:748-756. doi: 10.1902/jop.1971.42.12.748.
8. Svanberg G, Lindhe J. Vascular reactions in the periodontal ligament incident to trauma from occlusion. *J Clin Periodontol.* 1974;1:58-69. doi: 10.1111/j.1600-051x.1974.tb01240.x.
9. Polson AM, Kennedy JE, Zander HA. Trauma and progression of marginal periodontitis in squirrel monkeys. I. Co-destructive factors of periodontitis and thermally-produced injury. *J Periodontal Res.* 1974;9:100-107. doi: 10.1111/j.1600-0765.1974.tb00660.x.
10. Lindhe J, Svanberg G. Influence of trauma from occlusion on progression of experimental periodontitis in the beagle dog. *J Clin Periodontol.* 1974;1:3-14. doi: 10.1111/j.1600-051x.1974.tb01234.x.
11. Polson AM, Meitner SW, Zander HA. Trauma and progression of marginal periodontitis in squirrel monkeys. III Adaption of interproximal alveolar bone to repetitive injury. *J Periodontal Res.* 1976;11:279-289. doi: 10.1111/j.1600-0765.1976.tb00082.x.
12. Polson AM, Meitner SW, Zander HA. Trauma and progression of marginal periodontitis in squirrel monkeys. IV Reversibility of bone loss due to trauma alone and trauma superimposed upon periodontitis. *J Periodontal Res.* 1976;11:290-298. doi: 10.1111/j.1600-0765.1976.tb00083.x.
13. Lindhe J, Ericsson I. The influence of trauma from occlusion on reduced but healthy periodontal tissues in dogs. *J Clin Periodontol.* 1976;3:110-122. doi: 10.1111/j.1600-051x.1976.tb01857.x.
14. Ericsson I, Lindhe J. Lack of effect of trauma from occlusion on the recurrence of experimental periodontitis. *J Clin Periodontol.* 1977;4:115-127. doi: 10.1111/j.1600-051x.1977.tb01891.x.
15. Goldstein GR. The relationship of canine-protected occlusion to a periodontal index. *J Prosthet Dent.* 1979;41:277-283. doi: 10.1016/0022-3913(79)90007-6.
16. Waerhaug J. The angular bone defect and its relationship to trauma from occlusion and downgrowth of subgingival plaque. *J Clin Periodontol.* 1979;6:61-82. doi: 10.1111/j.1600-051x.1979.tb02185.x.

17. Waerhaug J. The infrabony pocket and its relationship to trauma from occlusion and subgingival plaque. *J Periodontol.* 1979;50:355-365. doi: 10.1902/jop.1979.50.7.355.
18. Fleszar TJ, Knowles JW, Morrison EC, Burgett FG, Nissle RR, Ramfjord SP. Tooth mobility and periodontal therapy. *J Clin Periodontol.* 1980;7:495-505. doi: 10.1111/j.1600-051x.1980.tb02156.x.
19. Ramfjord SP, Ash MM Jr. Significance of occlusion in the etiology and treatment of early, moderate, and advanced periodontitis. *J Periodontol.* 1981;52:511-517. doi: 10.1902/jop.1981.52.9.511.
20. Ramfjord SP, Ash MM Jr. Significance of occlusion in the etiology and treatment of early, moderate, and advanced periodontitis. *J Periodontol.* 1981;52:511-517. doi: 10.1902/jop.1981.52.9.511.
21. Carwell ML, McFall WT Jr. Centric relation determinations: clinical and radiographic comparisons. *J Periodontol.* 1981;52:347-353. doi: 10.1902/jop.1981.52.7.347.
22. Kerry GJ, Morrison EC, Ramfjord SP, et al. Effect of periodontal treatment on tooth mobility. *J Periodontol.* 1982;53:635-638. doi: 10.1902/jop.1982.53.10.635.
23. Lindhe J, Ericsson I. The effect of elimination of jiggling forces on periodontally exposed teeth in the dog. *J Periodontol.* 1982;53:562-567. doi: 10.1902/jop.1982.53.9.562.
24. Ericsson I, Lindhe J. Effect of longstanding jiggling on experimental marginal periodontitis in the beagle dog. *J Clin Periodontol.* 1982;9:497-503. doi: 10.1111/j.1600-051x.1982.tb02111.x.
25. Polson AM, Zander HA. Effect of periodontal trauma upon intrabony pockets. *J Periodontol.* 1983;54:586-591. doi: 10.1902/jop.1983.54.10.586.
26. Ericsson I, Lindhe J. Lack of significance of increased tooth mobility in experimental periodontitis. *J Periodontol.* 1984;55:447-452. doi: 10.1902/jop.1984.55.8.447.
27. Shefter GJ, McFall WT Jr. Occlusal relations and periodontal status in human adults. *J Periodontol.* 1984;55:368-374. doi: 10.1902/jop.1984.55.6.368.
28. Ericsson I. The combined effects of plaque and physical stress on periodontal tissues. *J Clin Periodontol.* 1986;13:918-922. doi: 10.1111/j.1600-051x.1986.tb01427.x.
29. Pihlstrom BL, Anderson KA, Aeppli D, Schaffer EM. Association between signs of trauma from occlusion and periodontitis. *J Periodontol.* 1986;57:1-6. doi: 10.1902/jop.1986.57.1.1.
30. Polson AM. The relative importance of plaque and occlusion in periodontal disease. *J Clin Periodontol.* 1986;13:923-927. doi: 10.1111/j.1600-051x.1986.tb01428.x.
31. Jin LJ, Cao CF. Clinical diagnosis of trauma from occlusion and its relation with severity of periodontitis. *J Clin Periodontol.* 1992;19:92-97. doi: 10.1111/j.1600-051x.1992.tb00446.x.
32. Burgett FG, Ramfjord SP, Nissle RR, Morrison EC, Charbeneau TD, Caffesse RG. A randomized trial of occlusal adjustment in the treatment of periodontitis patients. *J Clin Periodontol.* 1992;19:381-387. doi: 10.1111/j.1600-051x.1992.tb00666.x.
33. Neiderud AM, Ericsson I, Lindhe J. Probing pocket depth at mobile/nonmobile teeth. *J Clin Periodontol.* 1992;19:754-759. doi: 10.1111/j.1600-051x.1992.tb02166.x.
34. Norderyd O. Risk for periodontal disease in a Swedish adult population. Cross-sectional and longitudinal studies over two decades. *Swed Dent J Suppl.* 1998;132:1-67. PMID: 9972528
35. Hallmon WW. Occlusal trauma: effect and impact on the periodontium. *Ann Periodontol.* 1999;4:102-108. doi: 10.1902/annals.1999.4.1.102.

36. Nunn ME, Harrel SK. The effect of occlusal discrepancies on periodontitis. I. Relationship of initial occlusal discrepancies to initial clinical parameters. *J Periodontol*. 2001;72:485-494. doi: 10.1902/jop.2001.72.4.485.
37. Harrel SK, Nunn ME. The effect of occlusal discrepancies on periodontitis. II. Relationship of occlusal treatment to the progression of periodontal disease. *J Periodontol*. 2001;72:495-505. doi: 10.1902/jop.2001.72.4.495.
38. Kleinfelder JW, Ludwig K. Maximal bite force in patients with reduced periodontal tissue support with and without splinting. *J Periodontol*. 2002;73:1184-1187. doi: 10.1902/jop.2002.73.10.1184.
39. Harrel SK. Occlusal forces as a risk factor for periodontal disease. *Periodontol 2000*. 2003;32:111-117. doi: 10.1046/j.0906-6713.2002.03209.x.
40. Hallmon WW, Harrel SK. Occlusal analysis, diagnosis and management in the practice of periodontics. *Periodontol 2000*. 2004;34:151-164. doi: 10.1046/j.0906-6713.2003.003430.x.
41. Harrel SK, Nunn ME. The effect of occlusal discrepancies on gingival width. *J Periodontol*. 2004;75:98-105. doi: 10.1902/jop.2004.75.1.98.
42. Kim Y, Oh TJ, Misch CE, Wang HL. Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. *Clin Oral Implants Res*. 2005;16:26-35. doi: 10.1111/j.1600-0501.2004.01067.x.
43. Deas DE, Mealey BL. Is there an association between occlusion and periodontal destruction?: Only in limited circumstances does occlusal force contribute to periodontal disease progression. *J Am Dent Assoc*. 2006;137:1381, 1383, 1385 passim. doi: 10.14219/jada.archive.2006.0050.
44. Reyes E, Hildebolt C, Langenwalter E, Miley D. Abfractions and attachment loss in teeth with premature contacts in centric relation: clinical observations. *J Periodontol*. 2009;80:1955-62. doi: 10.1902/jop.2009.090149.
45. Grippo JO, Simring M, Coleman TA. Abfraction, abrasion, biocorrosion, and the enigma of noncarious cervical lesions: a 20-year perspective. *J Esthet Restor Dent*. 2012;24:10-23. doi: 10.1111/j.1708-8240.2011.00487.x.
46. Nakatsu S, Yoshinaga Y, Kuramoto A, et al. Occlusal trauma accelerates attachment loss at the onset of experimental periodontitis in rats. *J Periodontal Res*. 2014;49:314-322. doi: 10.1111/jre.12109.
47. Xu W, Lu Y, Yue J, et al. Occlusal trauma inhibits osteoblast differentiation and bone formation through IKK-NF-kappaB signaling. *J Periodontol*. 2020;91:683-692. doi: 10.1002/JPER.18-0710.

8.2 Selective adjustment, splinting, and removable appliances

Questions to be answered:

- What are the indications for occlusal adjustment?
- What are the effects of splinting on the periodontal tissues?
- What is the relevance of mobility in the progression of periodontal disease?

1. Rateitschak KH. The Therapeutic Effect of Local Treatment on Periodontal Disease Assessed upon Evaluation of Different Diagnostic Criteria 1. Changes in Tooth Mobility. *J Periodontol*. 1963;34:540-544. DOI: 10.1902/jop.1963.34.6.540
2. Glickman I, Smulow JB. Adaptive alterations in the periodontium of the rhesus monkey in chronic trauma from occlusion. *J Periodontol*. 1968;39:101-105. doi: 10.1902/jop.1968.39.2.101.
3. Lindhe J, Nyman S. The role of occlusion in periodontal disease and the biological rationale for splinting in treatment of periodontitis. *Oral Sci Rev*. 1977;10:11-43. PMID: 335305

4. Galler C, Selipsky H, Phillips C, Ammons WF Jr. The effect of splinting on tooth mobility. (2) After osseous surgery. *J Clin Periodontol.* 1979;6:317-333. doi: 10.1111/j.1600-051x.1979.tb01933.x.
5. Kegel W, Selipsky H, Phillips C. The effect of splinting on tooth mobility. I. During initial therapy. *J Clin Periodontol.* 1979;6:45-58. doi: 10.1111/j.1600-051x.1979.tb02290.x.
6. Fleszar TJ, Knowles JW, Morrison EC, Burgett FG, Nissle RR, Ramfjord SP. Tooth mobility and periodontal therapy. *J Clin Periodontol.* 1980;7:495-505. doi: 10.1111/j.1600-051x.1980.tb02156.x.
7. Pollack RP, Ponte PM. Treatment of types III and IV periodontal cases without crown and bridge splinting. *Int J Periodontics Restorative Dent.* 1981;1:26-49. PMID: 6954137
8. Kerry GJ, Morrison EC, Ramfjord SP, et al. Effect of periodontal treatment on tooth mobility. *J Periodontol.* 1982;53:635-638. doi: 10.1902/jop.1982.53.10.635.
9. Perrier M, Polson A. The effect of progressive and increasing tooth hypermobility on reduced but healthy periodontal supporting tissues. *J Periodontol.* 1982;53:152-157. doi: 10.1902/jop.1982.53.3.152.
10. Ericsson I, Lindhe J. Lack of significance of increased tooth mobility in experimental periodontitis. *J Periodontol.* 1984;55:447-452. doi: 10.1902/jop.1984.55.8.447.
11. Tarnow DP, Fletcher P. Splinting of periodontally involved teeth: indications and contraindications. *N Y State Dent J.* 1986;52:24-25. PMID: 3458099
12. Greenstein G, Polson A. Understanding tooth mobility. *Compendium.* 1988;9:470-479. PMID: 3073858
13. Burgett FG, Ramfjord SP, Nissle RR, Morrison EC, Charbeneau TD, Caffesse RG. A randomized trial of occlusal adjustment in the treatment of periodontitis patients. *J Clin Periodontol.* 1992;19:381-387. doi: 10.1111/j.1600-051x.1992.tb00666.x.
14. Ericsson I, Giargia M, Lindhe J, Neiderud AM. Progression of periodontal tissue destruction at splinted/non-splinted teeth. An experimental study in the dog. *J Clin Periodontol.* 1993;20:693-698. doi: 10.1111/j.1600-051x.1993.tb00693.x.
15. Nyman SR, Lang NP. Tooth mobility and the biological rationale for splinting teeth. *Periodontol 2000.* 1994;4:15-22. doi: 10.1111/j.1600-0757.1994.tb00002.x
16. Wang HL, Burgett FG, Shyr Y, Ramfjord S. The influence of molar furcation involvement and mobility on future clinical periodontal attachment loss. *J Periodontol.* 1994;65:25-29. doi: 10.1902/jop.1994.65.1.25.
17. Harrel SK, Nunn ME. The effect of occlusal discrepancies on periodontitis. II. Relationship of occlusal treatment to the progression of periodontal disease. *J Periodontol.* 2001;72:495-505. doi: 10.1902/jop.2001.72.4.495. PMID: 11338302.
18. Anderegg CR, Metzler DG. Tooth mobility revisited. *J Periodontol.* 2001;72:963-967. doi: 10.1902/jop.2001.72.7.963.
19. Hallmon WW, Harrel SK. Occlusal analysis, diagnosis and management in the practice of periodontics. *Periodontol 2000.* 2004;34:151-164. doi: 10.1046/j.0906-6713.2003.003430.x.
20. Harrel SK, Nunn ME. The association of occlusal contacts with the presence of increased periodontal probing depth. *J Clin Periodontol.* 2009;36:1035-1042. doi: 10.1111/j.1600-051X.2009.01486.x.
21. Passanezi E, Sant'Ana ACP. Role of occlusion in periodontal disease. *Periodontol 2000.* 2019;79:129-150. doi: 10.1111/prd.12251.

1. Foz AM, Artese HP, Horliana AC, Pannuti CM, Romito GA. Occlusal adjustment associated with periodontal therapy--a systematic review. *J Dent.* 2012;40:1025-1035. doi: 10.1016/j.jdent.2012.09.002.
2. Kathariya R, Devanoorkar A, Golani R, Shetty N, Vallakatla V, Bhat MY. To Splint or Not to Splint: The Current Status of Periodontal Splinting. *J Int Acad Periodontol.* 2016;18:45-56. PMID: 27128157
3. Fan J, Caton JG. Occlusal trauma and excessive occlusal forces: Narrative review, case definitions, and diagnostic considerations. *J Clin Periodontol.* 2018;45 Suppl 20:S199-S206. doi: 10.1111/jcpe.12949.
4. Dommisch H, Walter C, Difloë-Geisert JC, Gintaute A, Jepsen S, Zitzmann NU. Efficacy of tooth splinting and occlusal adjustment in patients with periodontitis exhibiting masticatory dysfunction: A systematic review. *J Clin Periodontol.* 2022;49 Suppl 24:149-166. doi: 10.1111/jcpe.13563.

9. General Surgical Principles

9.1 Anatomic considerations

Questions to be answered in this session:

- What are some general anatomic considerations in periodontal surgery?
 - What are tooth-specific anatomic considerations for periodontal surgery?
 - What is the anatomy of the lingual nerve?
 - What is the expected blood loss after surgery?
 - What is the incidence of postoperative infections in periodontal surgeries?
1. Clarke M, Bueltman K. Anatomic considerations in periodontal surgery. *J Periodontol.* 1971;42:610-625. PMID: 5285836 DOI: 10.1902/jop.1971.42.10.610
 2. Hunt P. Safety aspects of mandibular lingual surgery. *J Periodontol.* 1976;47:224-229. PMID: 1083904 DOI: 10.1902/jop.1976.47.4.224
 3. Baab D, Ammons W. Blood loss during periodontal flap surgery. *J Periodontol.* 1977;48:693-698. PMID: 303287 DOI: 10.1902/jop.1977.48.11.693
 4. Mormann W, Ciancio S. Blood supply of human gingiva following periodontal surgery - a fluorescein angiography study. *J Periodontol.* 1977;48:681-692. PMID: 269943 DOI: 10.1902/jop.1977.48.11.681
 5. Pack P, Haber J. The incidence of clinical infection after periodontal surgery. *J Periodontol.* 1983;54:441-443. PMID: 6577181 DOI: 10.1902/jop.1983.54.7.441
 6. Kiesselbach JE, Chamberlain JG. Clinical and anatomic observations on the relationship of the lingual nerve to the mandibular third molar region. *J Oral Maxillofac Surg.* 1984;42:565-567. PMID: 6590806 DOI: 10.1016/0278-2391(84)90085-5
 7. Langford RJ. The contribution of the nasopalatine nerve to sensation of the hard palate. *Br J Oral Maxillofac Surg.* 1989;27:379-386. PMID: 2804040 DOI: 10.1016/0266-4356(89)90077-6
 8. Gowgjal JM. The position and course of the mandibular canal. *J Oral Implantol.* 1992;18:383. PMID: 1298823
 9. De Andrade E, Otomo-Corgel J, Pucher J, Ranganath KA, St George N Jr. The intraosseous course of the mandibular incisive nerve in the mandibular symphysis. *Int J Periodontics Restorative Dent.* 2001;21:591-597. PMID: 11794570
 10. Kuzmanovic DV, Payne AG, Kieser JA, Dias GJ. Anterior loop of the mental nerve: a morphological and radiographic study. *Clin Oral Implants Res.* 2003;14:464-471. PMID: 12869009 DOI: 10.1034/j.1600-0501.2003.00869.x

Tooth anatomy considerations:

1. Bower RC. Furcation morphology relative to periodontal treatment. Furcation entrance architecture. *J Periodontol.* 1979;50:23-27. PMID: 283222 DOI: 10.1902/jop.1979.50.1.23
2. Bower RC. Furcation morphology relative to periodontal treatment. Furcation root surface anatomy. *J Periodontol.* 1979;50:366-374. PMID: 288913 DOI: 10.1902/jop.1979.50.7.366
3. Hermann DW, Gher ME Jr, Dunlap RM, Pelleu GB Jr. The potential attachment area of the maxillary first molar. *J Periodontol.* 1983;54:431-434. PMID: 6577179 DOI: 10.1902/jop.1983.54.7.431
4. Joseph I, Varma BR, Bhat KM. Clinical significance of furcation anatomy of the maxillary first premolar: a biometric study on extracted teeth. *J Periodontol.* 1996;67:386-389. PMID: 8708964 DOI: 10.1902/jop.1996.67.4.386

9.2 Incisions and flap designs

Questions to be answered from this session:

- What are the different incision designs used in periodontal surgery?
- What is the curtain flap technique?
- How do partial and full thickness flaps differ?
- What is an apically positioned flap?
- What are some various flap designs?

Incisions:

1. Cattermole A, Wade A. A comparison of the scalloped and linear incisions as used in the reverse bevel technique. *J Clin Periodontol.* 1978;5:41-49. PMID: 353086 DOI: 10.1111/j.1600-051x.1978.tb01905.x
2. Kalkwarf KL, Krejci RF, Wentz FM, Edison AR. Epithelial and connective tissue healing following electrosurgical incision in human gingiva. *J Oral Maxillofac Surg.* 1983;41:80-85. PMID: 6571885 DOI: 10.1016/0278-2391(83)90212-4
3. Litch J, O'Leary T. Pocket epithelium removal via crestal and subcrestal scalloped internal bevel incisions. *J Periodontol.* 1984;55:142-148. PMID: 6584589 DOI: 10.1902/jop.1984.55.3.142
4. Kon S, Caffesse RG, Castelli WA, Nasjleti CE. Vertical releasing incisions for flap design: clinical and histological study in monkeys. *Int J Periodontics Restorative Dent.* 1984;4:48-57. PMID: 6590522
5. Smith BA, Echeverri M, Caffesse RG. Mucoperiosteal flaps with and without removal of the pocket epithelium. *J Periodontol.* 1987;58:78-85. PMID: 3546671 DOI: 10.1902/jop.1987.58.2.78
6. Lynch TJ, Ficara AJ, Ekvall WM, Raulin LA, Rossmann JA, Scheidt MJ. A comparison of mandibular lingual surgical flaps with and without a vertical releasing incision. *J Periodontol.* 1988;59:12-17. PMID: 3422288 DOI: 10.1902/jop.1988.59.1.12
7. Deschner J, Wolff S, Hedderich J, Kreusch T, Jepsen S. Dimensional changes of periodontal soft tissues after intrasulcular incision. *Clin Oral Investig.* 2009;13:401-408. PMID: 19172314 DOI: 10.1007/s00784-009-0251-y

Curtain Procedure and Related Procedures for Maxillary Anterior Area:

1. Frisch J, Jones RA, Bhaskar SN. Conservation of maxillary anterior esthetics: A modified surgical approach. *J Periodontol.* 1967;38:11-17. PMID: 5225805 DOI: 10.1902/jop.1967.38.1.11

2. Nordenram A, Landt H. Evaluation of a surgical technique in the periodontal treatment of maxillary anterior teeth. *Acta Odontol Scand*. 1969;27:283-289. PMID: 5257034 DOI: 10.3109/00016356909008957
3. Levine HL. Periodontal flap surgery with gingival fiber retention. *J Periodontol*. 1972;43:91-98. PMID: 4501913 DOI: 10.1902/jop.1972.43.2.91
4. Dello Russo NM. Use of the fiber retention procedure in treating the maxillary anterior region. *J Periodontol*. 1981;52:208-213. PMID: 6939840 DOI: 10.1902/jop.1981.52.4.208
5. Takei H, Hahn T, Carranza F Jr., Kenney EB, Lekovic V. Flap technique for periodontal bone implants. Papilla preservation technique. *J Periodontol*. 1985;56:204-210. PMID: 3889270 DOI: 10.1902/jop.1985.56.4.204
6. Newell DH, Brunsvold MA. A modification of the “Curtain Technique” incorporating an internal mattress suture. *J Periodontol*. 1985;56:484-487. PMID: 3915014 DOI: 10.1902/jop.1985.56.8.484
7. Lie T. Periodontal surgery for the maxillary anterior area. *Int J Periodontics Restorative Dent*. 1992;12(1):72-81. PMID: 1526713
8. Michaelides PL, Wilson SG. A comparison of papillary retention versus full-thickness flaps with internal mattress sutures in anterior periodontal surgery. *Int J Periodontics Restorative Dent*. 1996;16:388-397. PMID: 9242106

Split Thickness Flap:

Clinical

Staffileno H. Significant differences and advantages between the full thickness and split thickness flaps. *J Periodontol* 1974;45:421-425. PMID: 4525958 DOI: 10.1902/jop.1974.45.6.421

Histological

1. Staffileno H, Wentz FM, Orban BJ. Histologic study of healing of split thickness flap surgery in dogs. *J Periodontol* 1962;33:56-69.
2. Kon S, Caffesse RG, Castelli WA, Nasjleti CE. Revascularization following a combined gingival flap-split thickness flap procedure in monkeys. *J Periodontol* 1984;55:345-351. PMID: 6588191 DOI: 10.1902/jop.1984.55.6.345

Flap position:

Clinical:

3. Friedman N. Mucogingival surgery: the apically repositioned flap. *J Periodontol* 1962;34:328-339.
4. Pritchard JF. Present state of the interdental denudation procedures. *J Periodontol* 1977;48:566-569. PMID: 333089 DOI: 10.1902/jop.1977.48.9.566
5. Machtei EE, Ben-Yehouda A. The effect of post-surgical flap placement on probing depth and attachment level: A 2-year longitudinal study. *J Periodontol* 1994;65:855-858. PMID: 7990022 DOI: 10.1902/jop.1994.65.9.855

Histological

6. Kohler CA, Ramfjord SP. Healing of gingival mucoperiosteal flaps. *Oral Surg* 1960;13:89-103. PMID: 14410539 DOI: 10.1016/0030-4220(60)90400-x
7. Costich ER, Ramfjord SP. Healing after partial denudation of the alveolar process. *J Periodontol* 1968;39:127-134. PMID: 5240004 DOI: 10.1902/jop.1968.39.3.127

Reviews:

8. Johnson RH. Basic flap management. *Dent Clin N Am* 1976;20:3-21. PMID: 765173
9. Barrington EP. An overview of periodontal surgical procedures. *J Periodontol* 1981;52:518-528. PMID: 7026757 DOI: 10.1902/jop.1981.52.9.518

9.3 Sutures, dressing, techniques

What questions are answered in this session:

- Is the use of surgical dressing in periodontal surgery beneficial?
- What are some different suture materials and their use in periodontal surgery?
- What are material properties of varying suture materials?
- What are some common suturing techniques used in periodontal surgery?

Dressing:

1. Allen D, Caffesse R. Comparison of results following modified Widman flap surgery with and without surgical dressing. *J Periodontol* 1983; 54:470-475. PMID: 6352896 DOI: 10.1902/jop.1983.54.8.470

Suture materials:

2. Castelli WA, Nasjleti CE, Caffesse RE, Diaz-Perez R. Gingival response to silk, cotton, and nylon suture materials. *Oral Surg Oral Med Oral Pathol* 1978;45:179-85. PMID: 415276 DOI: 10.1016/0030-4220(78)90083-x
3. Hutchens LH. A review of needles, materials and techniques. *Postgrad Dent* 1995; 2:3-15.
4. Charbit Y, Hitzig C, Bolla M, Bitton C, Bertrand MF. Comparative study of physical properties of three suture materials: silk, e-PTFE (Gore-Tex), and PLA/PGA (Vicryl). *Biomed Instrum Technol* 1999;33:71-5. PMID: 10067182
5. Leknes KN, Roynstrand IT, Selvig KA. Human gingival tissue reactions to silk and expanded polytetrafluoroethylene sutures. *J Periodontol* 2005;76:34-42. PMID: 15830635 DOI: 10.1902/jop.2005.76.1.34

Suturing technique:

6. Morris ML. Suturing techniques in periodontal surgery. *Periodontics* 1965;59:84-9. PMID: 14261517
7. Kramer GM, Nevins M, Kohn JD. The utilization of periosteal suturing in periodontal surgical procedures. *J Periodontol* 1970;41:457-62. PMID: 4915978 DOI: 10.1902/jop.1970.41.8.457
8. Nelson EH, Funakoshi E, O'Leary TJ. A comparison of the continuous and interrupted suturing techniques. *J Periodontol* 1977;48:273-81. PMID: 323453 DOI: 10.1902/jop.1977.48.5.273
9. Newell D, Brunsvold M. A modification of the "curtain technique" incorporating an internal mattress suture. *J Periodontol* 1985; 56:484-487. PMID: 3915014 DOI: 10.1902/jop.1985.56.8.484

10. Moore RL, Hill M. Suturing techniques for periodontal plastic surgery. *Periodontol 2000* 1996;11:103-11. PMID: 9567962 DOI: 10.1111/j.1600-0757.1996.tb00188.x
11. Griffin T, Yong H, Bu J. Basic Suture Techniques for Oral Mucosa. *Clin Adv in Perio* 2011; 1:221-232.

9.4 Complications

Questions to be answered in this session:

- What are common post-operative complications after surgery?
 - How is the duration of surgery associated with potential complications?
 - What is the effect of mouth rinse on soft tissue healing?
 - How does soft tissue craters form after periodontal surgery?
1. Levine MP, Grower MF, Cutright DE, Getter L. The effects of length of surgery on healing of full and partial thickness flaps. *J Oral Pathol.* 1977;6:152-160. PMID: 405466 DOI: 10.1111/j.1600-0714.1977.tb01876.x
 2. Baab DA, Ammons WF, Selipsky H. Blood loss during periodontal flap surgery. *J Periodontol.* 1977;48:693-698. PMID: 303287 DOI: 10.1902/jop.1977.48.11.693
 3. Pack P, Haber J. The incidence of clinical infection after periodontal surgery. *J Periodontol.* 1983;54:441-443. PMID: 6577181 DOI: 10.1902/jop.1983.54.7.441
 4. Knapp JF, Fiori T. Oral hemorrhage associated with periodontal surgery and hypertensive crisis. *J Am Dent Assoc.* 1984;108:49-51. PMID: 6607271 DOI: 10.14219/jada.archive.1984.0204
 5. Buckley JA, Ciancio SG, McMullen JA. Efficacy of epinephrine concentration in local anesthesia during periodontal surgery. *J Periodontol.* 1984;55:653-657. PMID: 6594502 DOI: 10.1902/jop.1984.55.11.653
 6. Jenkins WMM, Wragg PF, Gilmour WH. Formation of interdental soft tissue defects after surgical treatment of periodontitis. *J Periodontol.* 1990;61:564-570. PMID: 2213466 DOI: 10.1902/jop.1990.61.9.564
 7. Shahan MH, Chuang AH, Brennan WA, Dirksen TR, Van Dyke TE, McPherson JC. The effect of chlorhexidine irrigation on tensile wound strength. *J Periodontol.* 1993;64:719-722. PMID: 8410610 DOI: 10.1902/jop.1993.64.8.719

10. Gingivectomy & Gingivoplasty

10.1 Wound healing after gingivectomy

Questions to be answered in this session:

- How does the wound heal after gingivectomy?
- What are some available histology of soft tissue healing after gingivectomy?

Animal studies

1. Engler WO, Ramfjord SP, Hiniker JJ. Healing following simple gingivectomy. A tritiated thymidine radioautographic study. I. Epithelialization. *J Periodontol.* 1966;37:298-308. PMID: 4287364 DOI: 10.1902/jop.1966.37.4.298
2. Ramfjord SP, Engler WO, Hiniker JJ. A radioautographic study of healing following simple gingivectomy. II. The connective tissue. *J Periodontol.* 1966;37:179-189. PMID: 4956575 DOI: 10.1902/jop.1966.37.3.179
3. Listgarten M. Ultrastructure of the dentogingival junction after gingivectomy. *J Periodont Res.* 1972;7:51-160. PMID: 4272041 DOI: 10.1111/j.1600-0765.1972.tb00640.x

Reviews:

Waite IM. The present status of the gingivectomy procedure. *J Clin Periodontol.* 1975;2:241-249. PMID: 1061722 DOI: 10.1111/j.1600-051x.1975.tb01748.x

10.2 Techniques

Questions to be answered in this session:

- What is the detailed description of gingivectomy procedure?
- What are the healing outcomes after gingivectomy?

Conventional gingivectomy

1. Glickman I. The Results Obtained with an Unembellished Gingivectomy Technique in a Clinical Study in Humans. *J Periodontol.* 1956;27:247-255.
2. Ramfjord SP, Costich ER. Healing after simple gingivectomy. *J Periodontol.* 1963;34:401-415.
3. Donnenfeld OW, Glickman I. A biometric study of the effects of gingivectomy. *J Periodontol.* 1966;37:447-452. PMID: 5224011 DOI: 10.1902/jop.1966.37.6.447
4. Stahl SS, Witkin GJ, Cantor M, Brown R. Gingival healing. II. Clinical and histologic repair sequences following gingivectomy. *J Periodontol.* 1968;39:109-118. PMID: 4171465 DOI: 10.1902/jop.1968.39.2.109
5. Afshar-Mohajer K, Stahl SS. The remodeling of human gingival tissues following gingivectomy. *J Periodontol.* 1977;48:136-139. PMID: 264962 DOI: 10.1902/jop.1977.48.3.136
6. Wennstrom J. Regeneration of gingiva following surgical excision. A clinical study. *J Clin Periodontol.* 1983;10:287-297. PMID: 6192155 DOI: 10.1111/j.1600-051x.1983.tb01277.x
7. Proestakis G, Soderholm G, Bratthall G, et al. Gingivectomy versus flap surgery: the effect of the treatment of infrabony defects. A clinical and radiographic study. *J Clin Periodontol.* 1992;19:497-508. PMID: 1430286 DOI: 10.1111/j.1600-051x.1992.tb01163.x
8. Rossmann J, Ingles E and Brown R. Multimodal treatment of drug-induced gingival hyperplasia in a kidney transplant patient. *Compend Cont Ed Dent.* 1994;15:1266-1274. PMID: 7987892
9. Pilloni A, Camargo PM, Carere M, Carranza Jr FA. Surgical treatment of cyclosporine A- and nifedipine-induced gingival enlargement: gingivectomy versus periodontal flap. *J Periodontol.* 1998;69:791-797. PMID: 9706857 DOI: 10.1902/jop.1998.69.7.791
10. Zitzmann NU, Berglundh T, Lindhe J. Inflammatory lesions in the gingiva following resective/non-resective periodontal therapy. *J Clin Periodontol.* 2005;32:139-146. PMID: 15691342 DOI: 10.1111/j.1600-051X.2005.00649.x

Electrosurgery gingivectomy

Kalkwarf KL, Krejci RF, Wentz FM, Edison AR. Epithelial and connective tissue healing following electrosurgical incision in human gingiva. *J Oral Maxillofac Surg* 1983;41:80-85. PMID: 6571885 DOI: 10.1016/0278-2391(83)90212-4

11. Surgical Techniques

11.1 Flap Curettage and ENAP

Questions to be answered in this session:

- What are various flap and curettage procedures?
 - What is ENAP?
 - How do tissues heal after flap and curettage procedures?
1. Frisch J, Jones R. Conservation of maxillary anterior esthetics. A modified surgical approach. *J Periodontol.* 1967;38:11-17. PMID: 5225805 DOI: 10.1902/jop.1967.38.1.11
 2. Ammons WF, Smith DH. Flap curettage: rationale, technique, and expectations. *Dent Clin N Am.* 1976;20:215-225. PMID: 1061690
 3. Yukna RA, Bowers GM, Lawrence JJ, Fedi PF Jr. A clinical study of healing in humans following the excisional new attachment procedure. *J Periodontol.* 1976;47:696-700. PMID: 1069122 DOI: 10.1902/jop.1976.47.12.696
 4. Yukna RA. A clinical and histologic study of healing following the excisional new attachment procedures in rhesus monkeys. *J Periodontol.* 1976;47:701-709. PMID: 825631 DOI: 10.1902/jop.1976.47.12.701
 5. Yukna RA. Longitudinal evaluation of the excisional new attachment procedure in humans. *J Periodontol.* 1978;49:142-144. PMID: 288901 DOI: 10.1902/jop.1978.49.3.142

11.2 Modified Widman Flap

Questions to be answered from this session:

- What is a modified widman flap?
- How do tissues heal after modified widman flap?

Clinical

1. Kirkland O. The suppurative periodontal pus pocket; its treatment by the modified flap operation. *JADA* 1931;18:1462-1470.
2. Ramfjord SP, Nissle RR. The modified Widman flap. *J Periodontol* 1974;45:601–607. PMID: 4529305 DOI: 10.1902/jop.1974.45.8.2.601
3. Smith BA, Echeverri M, Caffesse RG. Mucoperiosteal flaps with and without removal of the pocket epithelium. *J Periodontol* 1987;58:78-85. PMID: 3546671 DOI: 10.1902/jop.1987.58.2.78

Histological (Animal)

1. Caton J, Nyman S. Histometric evaluation of periodontal surgery. I. The modified Widman Flap procedure. *J Clin Periodontol* 1980;7:212-223. PMID: 6933162 DOI: 10.1111/j.1600-051x.1980.tb01964.x
2. Caffesse RG, Castelli WA, Nasjleti CE. Vascular response to modified Widman flap surgery in monkeys. *J Periodontol* 1981;52:1-7. PMID: 6162939 DOI: 10.1902/jop.1981.52.1.1

11.3 Apically Positioned Flap

Questions to be answered from this session:

- What is an apically positioned flap?
- What does repositioning the flap do after apically positioning the flap?
- Where is the position of the mucogingival junction after APF?

1. Nabers C. Repositioning the attached gingiva. *J Periodontol* 1954;25:38-39. DOI: 10.1902/jop.1954.25.1.38
2. Ariaudo A, Tyrrell H. Repositioning and increasing the zone of attached gingiva. *J Periodontol* 1957;28:106-110. DOI: 10.1902/jop.1999.70.9.1110
3. Friedman N. Mucogingival surgery: The apically repositioned flap. *J Periodontol* 1962;33:328-340. DOI: 10.1902/jop.1962.33.4.328
4. Donnenfeld W, et al. The apically positioned flap: A clinical study. *J Periodontol* 1964;35:381-387. DOI: 10.1902/JOP.1964.35.5.381
5. Tavtigan R. The height of the facial radicular alveolar crest following apically positioned flap. *J Periodontol* 1970;41:412-418. PMID: 5269975 DOI: 10.1902/jop.1970.41.7.412
6. Fagan F, Freeman E. Clinical comparison of the free gingival graft and the partial thickness apically positioned flap. *J Periodontol* 1974;45:3-8. PMID: 4588355 DOI: 10.1902/jop.1974.45.1.3
7. Holmes C, Strem B. Location of flap margin after suturing. *J Periodontol* 1976;47:674-675. PMID: 1068276 DOI: 10.1902/jop.1976.47.11.674
8. Lindhe J, Nyman S. Alterations of the position of the marginal soft tissue following periodontal surgery. *J Clin Periodontol* 1980;7:525-530. PMID: 6163795 DOI: 10.1111/j.1600-051x.1980.tb02159.x
9. Pippin D. Fate of pocket epithelium in an apically positioned flap. *J Clin Periodontol* 1990;17:385-391. PMID: 2398136 DOI: 10.1111/j.1600-051x.1990.tb00035.x
10. Jenkins W, et al. Formation of interdental soft tissue defects after surgical treatment of periodontitis. *J Periodontol* 1990;61:564-570. PMID: 2213466 DOI: 10.1902/jop.1990.61.9.564
11. Ainamo A, et al. Location of the mucogingival junction 18 years after apically repositioned flap surgery. *Clin Periodont* 1992;19:49-52. PMID: 1732309 DOI: 10.1111/j.1600-051x.1992.tb01148.x

11.4 Retromolar Procedures

Questions answered in this session:

- What is the rationale for distal wedge procedure?
- What are some common distal wedge designs?

1. Robinson R. The distal wedge operation. *Periodontics* 1966;4:256-264. PMID: 5223126
2. Braden R. Deep distal pockets adjacent to terminal teeth. *DCNA* 1969;13:161-168. PMID: 5249427
3. Sussman HI, Simring M. The distal wedge operation in periodontal therapy; a two-year evaluation. *J Oral Med* 1972;27:106-109. PMID: 4507660
4. Pollack RP. Modified distal wedge procedure. *J Periodontol* 1980;51:513-515. PMID: 6932505 DOI: 10.1902/jop.1980.51.9.513
5. Saadoun AP. Surgical management of the maxillary tuberosity area. *Compend Contin Educ Dent* 1984;5:34-40. PMID: 6586392

11.5 Osseous Surgery

Questions to be answered from this session:

- What is the rationale for osseous surgery?

- Are there different approaches to osseous surgery?
- How is the healing after osseous surgery?

Clinical studies

1. Schluger S. Osseous resection; a basic principle in periodontal surgery. *Oral Surg Oral Med Oral Pathol*. 1949 Mar;2(3):316-25. doi: 10.1016/0030-4220(49)90363-1. PMID: 18112168.
2. Friedman, N. Periodontal osseous surgery: Osteoplasty and osteoectomy. *J. Periodontol.* 1955;26:257-269. DOI: 10.1902/JOP.1955.26.4.257
3. Carrara, J., et al. Effect of bone denudation in mucogingival surgery in humans. *J Periodontol* 1964;35:463-466,1964.
4. Ochsenbein, C. and Bohannan, H. The palatal approach to osseous surgery. *J Periodontol*;34:60-68, 1963. Clinical application. *J Periodontol*;1967;35:54-68. DOI: 10.1902/JOP.1963.34.1.60
5. Ochsenbein C, Bohannan HM. The palatal approach to osseous surgery. II. Clinical application. *J Periodontol* 1964;35:54-68. DOI: 10.1902/JOP.1964.35.1.54
6. Pennel BM, King KO, Wilderman MN, Barron JM. Repair of the alveolar process following osseous surgery. *J Periodontol* 1967;38:426-31. PMID: 5232090 DOI: 10.1902/jop.1967.38.5.426
7. Donnenfeld OW, Hoag PM, Weissman DP. A clinical study on the effects of osteoplasty. *J Periodontol* 1970;41:131-41. PMID: 5265933 DOI: 10.1902/jop.1970.41.3.131
8. Wilderman, M., et al. Histogenesis of repair following osseous surgery. *J Periodontol*;41:551-565, 1970. PMID: 4918577 DOI: 10.1902/jop.1970.41.10.551
9. Wood DL, Hoag PM, Donnenfeld OW, Rosenfeld LD. Alveolar crest reduction following full and partial thickness flaps. *J Periodontol* 1972;43:141-144. PMID: 4501971 DOI: 10.1902/jop.1972.43.3.141
10. Lindhe J, Nyman S. The effect of plaque control and surgical pocket elimination on the establishment and maintenance of periodontal health. A longitudinal study of periodontal therapy in cases of advanced disease. *J Clin Periodontol* 1975;2:67-79. PMID: 1055729 DOI: 10.1111/j.1600-051x.1975.tb01727.x
11. Galler C, Selipsky H, Phillips C, Ammons WF Jr. The effect of splinting on tooth mobility after osseous surgery. *J Clin Periodontol* 1979;6:317-33. PMID: 294458 DOI: 10.1111/j.1600-051x.1979.tb01933.x
12. Lindhe J, Nyman S. Alterations of the position of the marginal soft tissue following periodontal surgery. *J Clin Periodontol* 1980;7:525-30. PMID: 6163795 DOI: 10.1111/j.1600-051x.1980.tb02159.x
13. Smith DH, Ammons WF Jr, Van Belle G. A longitudinal study of peridontal status comparing osseous recontouring with flap curettage. I. Results after 6 months. *J Periodontol* 1980 Jul;51(7):367-75. PMID: 6930476 DOI: 10.1902/jop.1980.51.7.367
14. Moghaddas H, Stahl SS. Alveolar bone remodeling following osseous surgery: a clinical study. *J Periodontol* 1980;51:376-381. PMID: 6930477 DOI: 10.1902/jop.1980.51.7.376
15. Becker W, Berg L, Becker BE. The long term evaluation of periodontal treatment and maintenance in 95 patients. *Int J Periodontics Restorative Dent* 1984;4(2):54-71. PMID: 6589217
16. Olsen CT, Ammons WF, van Belle G. A longitudinal study comparing apically repositioned flaps, with and without osseous surgery. *Int J Periodontics Restorative Dent* 1985;5(4):10-33. PMID: 3864760
17. Ochsenbein C. A primer for osseous surgery. *Int J Periodontics Restorative Dent* 1986;6(1):8-47. PMID: 3457776

18. Becker W, Becker BE, Caffesse R, Kerry G, Ochsenbein C, Morrison E, Prichard J. A longitudinal study comparing scaling, osseous surgery, and modified Widman procedures: results after 5 years. *J Periodontol* 2001;72:1675-84. PMID: 11811503 DOI: 10.1902/jop.2001.72.12.1675

Histological (animal) studies

Caton J, Nyman S. Histometric evaluation of periodontal surgery. III. The effect of bone resection on the connective tissue attachment level. *J Periodontol* 1981;52:405-409. PMID: 6943327 DOI: 10.1902/jop.1981.52.8.405

11.6 Longitudinal Studies

Questions to be answered from this session:

What are the long-term outcomes for different periodontal procedures?

Michigan Studies

1. Ramfjord SP, Knowles JW, Nissle RR, Shick RA, Burgett. Longitudinal study of periodontal therapy. *J Periodontol*. 1973;44:66-77. PMID: 4509540 DOI: 10.1902/jop.1973.44.2.66
2. Morrison EC, Ramfjord SP, Hill RW. Short-term effects of initial, nonsurgical periodontal treatment (hygienic phase). *J Clin Periodontol*. 1980;7:199-211. PMID: 7000853 DOI: 10.1111/j.1600-051x.1980.tb01963.x
3. Hill RW, Ramfjord SP, Morrison EC, Appleberry EA, Caffesse RG, Kerry GJ, Nissle RR. Four types of periodontal treatment compared over two years. *J Periodontol*. 1981;52:655-62. PMID: 7028941 DOI: 10.1902/jop.1981.52.11.655
4. Ramfjord SP. Longitudinal evaluation of periodontal therapy. *Quintessence Int Dent Dig*. 1981;12:43-8. PMID: 6941326
5. Rams TE, Oler J, Listgarten MA, Slots J. Utility of Ramfjord index teeth to assess periodontal disease progression in longitudinal studies. *Clin Periodontol*. 1993;20:147-50. PMID: 8436634 DOI: 10.1111/j.1600-051x.1993.tb00330.x

Gothenburg Studies

1. Lindhe J, Nyman S. The effect of plaque control and surgical pocket elimination on the establishment and maintenance of periodontal health. A longitudinal study of periodontal therapy in cases of advanced disease. *J Clin Periodontol*. 1975;2:67-79. PMID: 1055729 DOI: 10.1111/j.1600-051x.1975.tb01727.x
2. Lindhe J, Westfelt E, Nyman S, Socransky SS, Haffajee AD. Long-term effect of surgical/non-surgical treatment of periodontal disease. *J Clin Periodontol*. 1984;11:448-58. PMID: 6378986 DOI: 10.1111/j.1600-051x.1984.tb01344.x
3. Lindhe J, Nyman S. Long-term maintenance of patients treated for advanced periodontal disease. *J Clin Periodontol*. 1984;11:504-14. PMID: 6384275 DOI: 10.1111/j.1600-051x.1984.tb00902.x
4. Axelsson P, Nystrom B, Lindhe J. The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *J Clin Periodontol*. 2004;31:749-57. PMID: 15312097 DOI: 10.1111/j.1600-051X.2004.00563.x

Nebraska Studies

1. Kaldahl WB, Kalkwarf KL, Patil KD, Molvar MP, Dyer JK. Long-term evaluation of periodontal therapy: I. Response to 4 therapeutic modalities. *J Periodontol.* 1996;67:93-102. PMID: 8667142 DOI: 10.1902/jop.1996.67.2.93
2. Kaldahl WB, Kalkwarf KL, Patil KD, Molvar MP, Dyer JK. Long-term evaluation of periodontal therapy: II. Incidence of sites breaking down. *J Periodontol.* 1996;67:103-8. PMID: 8667129 DOI: 10.1902/jop.1996.67.2.103

Tuscon Studies

1. Becker W, Becker BE, Ochsenbein C, Kerry G, Caffesse R, Morrison EC, Prichard J. A longitudinal study comparing scaling, osseous surgery and modified Widman procedures. Results after one year. *J Periodontol.* 1988;59:351-65. PMID: 3292752 DOI: 10.1902/jop.1988.59.6.351
2. Becker W, Becker BE, Ochsenbein C, Kerry G, Caffesse R, Morrison EC, Prichard J. A longitudinal study comparing scaling, osseous surgery, and modified Widman procedures: results after 5 years. *J Periodontol.* 2001;72:1675-84. PMID: 11811503 DOI: 10.1902/jop.2001.72.12.1675

Minnesota Study

1. Pihlstrom B, Ortiz-Campos C, McHugh R. A randomized four-year study of periodontal therapy. *J Periodontal.* 1981;52:227-242. PMID: 7017103 DOI: 10.1902/jop.1981.52.5.227
2. Pihlstrom BL, McHugh RB, Oliphant TH, Ortiz-Campos C. Comparison of surgical and nonsurgical treatment of periodontal disease. A review of current studies and additional results after 6 ½ years. *J Clin Periodontol.* 1983;10:524-41. PMID: 6355204 DOI: 10.1111/j.1600-051x.1983.tb02182.x
3. Pihlstrom B, Oliphant T, McHugh R. Molar and nonmolar teeth compared over 6-1/2 years following two methods of periodontal therapy. *J Periodontol.* 1984;55:499-504. PMID: 6384466 DOI: 10.1902/jop.1984.55.9.499

12. Crown-lengthening Surgery

12.1 Indications for crown-lengthening surgery

Questions to be answered from this section

- What is the relationship between restorative and periodontal health?
- Is there a specific dimension of periodontium to maintain health?

1. Ingber JS, Rose LF, Coslet JG. The "biologic width"--a concept in periodontics and restorative dentistry. *Alpha Omega.* 1977 Dec;70(3):62-5. PMID: 276259.
2. Maynard JG Jr, Wilson RD. Physiologic dimensions of the periodontium significant to the restorative dentist. *J Periodontol.* 1979 Apr;50(4):170-4. PMID: 286038.
3. Dragoo MR, Williams GB. Periodontal tissue reactions to restorative procedures. *Int J Periodontics Restorative Dent.* 1981 Apr;1(1):8-23. PMID: 6940852.
4. Dragoo MR, Williams GB. Periodontal tissue reactions to restorative procedures, part II. *Int J Periodontics Restorative Dent.* 1982;2(2):34-45. PMID: 6955294.
5. Tal H, Soldinger M, Dreangel A, Pitaru S. Periodontal response to long-term abuse of the gingival attachment by supracrestal amalgam restorations. *J Clin Periodontol.* 1989;16(10):654-9. PMID: 2613933 DOI: 10.1111/j.1600-051x.1989.tb01035.x.

6. Gunay H, Seeger A, Tschermitschek H, Geurtsen W. Placement of the preparation line and periodontal health—A prospective 2-year clinical study. *Int J Periodontics Restorative Dent.* 2000;20(2):173-181. PMID: 11203559

Reviews:

1. Hempton TJ, Dominici JT. Contemporary crown-lengthening therapy: a review. *J Am Dent Assoc.* 2010 Jun;141(6):647-55. PMID: 20516094 DOI: 10.14219/jada.archive.2010.0252.
2. Pilalas I, Tsalikis L, Tatakis DN. Pre-restorative crown lengthening surgery outcomes: a systematic review. *J Clin Periodontol.* 2016 Dec;43(12):1094-1108. PMID: 27535216 DOI: 10.1111/jcpe.12617.
3. Marzadori M, Stefanini M, Sangiorgi M, Mounssif I, Monaco C, Zucchelli G. Crown lengthening and restorative procedures in the esthetic zone. *Periodontol 2000.* 2018 Jun;77(1):84-92. PMID: 29493814 DOI: 10.1111/prd.12208.
4. Mele M, Felice P, Sharma P, Mazzotti C, Bellone P, Zucchelli G. Esthetic treatment of altered passive eruption. *Periodontol 2000.* 2018 Jun;77(1):65-83. PMID: 29504162 DOI: 10.1111/prd.12206.

12.2 Gingivectomy

Stahl SS, Witkin GJ, Cantor M, Brown R. Gingival healing. II. Clinical and histologic repair sequences following gingivectomy. *J Periodontol.* 1968 Mar;39(2):109-18. doi: 10.1902/jop.1968.39.2.109. PMID: 4171465.

12.3 Functional crown lengthening surgery

Questions to be answered from this section:

- What is the surgical technique to lengthen the clinical tooth structure for restoration
 - What is the timeline for the healing after crown lengthening procedure
 - What is the dimensional change of supracrestal attachment after crown lengthening procedure
 - How does the wound heal after crown lengthening procedure in histologic evaluation?
1. Ross SE, Garguilo A. The surgical management of the restorative alveolar interface. *Int J Periodontics Restorative Dent.* 1982;2(3):8-31. PMID: 6757165.
 2. Brägger U, Lauchenauer D, Lang NP. Surgical lengthening of the clinical crown. *J Clin Periodontol.* 1992 Jan;19(1):58-63. PMID: 1732311 DOI: 10.1111/j.1600-051x.1992.tb01150.x.
 3. Herrero F, Scott JB, Maropis PS, Yukna RA. Clinical comparison of desired versus actual amount of surgical crown lengthening. *J Periodontol.* 1995 Jul;66(7):568-71. PMID: 7562348 DOI: 10.1902/jop.1995.66.7.568.
 4. Pontoriero R, Carnevale G. Surgical crown lengthening: a 12-month clinical wound healing study. *J Periodontol.* 2001 Jul;72(7):841-8. PMID: 11495130 DOI: 10.1902/jop.2001.72.7.841.
 5. Deas DE, Moritz AJ, McDonnell HT, Powell CA, Mealey BL. Osseous surgery for crown lengthening: a 6-month clinical study. *J Periodontol.* 2004 Sep;75(9):1288-94. PMID: 15515347 DOI: 10.1902/jop.2004.75.9.1288.
 6. Perez, Smukler, Nunn. Clinical Evaluation of the Supraosseous Gingivae before and after crown lengthening. *J Periodontol.* 2007;78:1023-1030. PMID: 17539715 DOI: 10.1902/jop.2007.060485.
 7. Arora R, Narula SC, Sharma RK, Tewari S. Evaluation of supracrestal gingival tissue after surgical crown lengthening: a 6-month clinical study. *J Periodontol.* 2013 Jul;84(7):934-40. PMID: 23088528 DOI: 10.1902/jop.2012.120162.

- Oakely E, Rhyu IC, Karatzas S, Gandini-Santiago L, Nevins M, Caton J. Formation of the biologic width following crown lengthening in nonhuman primates. *Int J Periodontics Restorative Dent.* 1999;19(6):529-541. PMID: 10815592.

12.4 Excessive gingival display

- Coslet JG, Vanarsdall R, Weisgold A. Diagnosis and classification of delayed passive eruption of the dentogingival junction in the adult. *Alpha Omegan.* 1977 Dec;70(3):24-8. PMID: 276255.
- Robbins JW. Differential diagnosis and treatment of excess gingival display. *Pract Periodontics Aesthet Dent.* 1999 Mar;11(2):265-72; quiz 273. PMID: 10321231.

12.5 Esthetic crown lengthening surgery

Questions to be answered from this section:

- How do we diagnose and plan treatment to enhance gingival aesthetics ?
- What is the surgical technique to lengthen the clinical tooth structure for restoration?
- What is patients' assessment of outcomes of crown lengthening procedure?

- Sonick M. Esthetic crown lengthening for maxillary anterior teeth. *Compend Contin Educ Dent.* 1997 Aug;18(8):807-12, 814-6, 818-9; quiz 820. PMID: 9533339.
- Reddy MS. Achieving gingival esthetics. *J Am Dent Assoc.* 2003 Mar;134(3):295-304; quiz 337-8. doi: 10.14219/jada.archive.2003.0158. PMID: 12699043.
- Lee EA. Aesthetic crown lengthening: classification, biologic rationale, and treatment planning considerations. *Pract Proced Aesthet Dent.* 2004 Nov-Dec;16(10):769-78; quiz 780. PMID: 15739921.
- Kao R, Dault S, Frangadakis K, Salehieh JJ. Esthetic crown lengthening: appropriate diagnosis for achieving gingival balance. *J Calif Dent Assoc.* 2008;36:187-91.
- Malkinson S, Waldrop TC, Gunsolley JC, Lanning SK, Sabatini R. The effect of esthetic crown lengthening on perceptions of a patient's attractiveness, friendliness, trustworthiness, intelligence, and self-confidence. *J Periodontol.* 2013 Aug;84(8):1126-33. doi: 10.1902/jop.2012.120403. Epub 2012 Nov 9. PMID: 23137007.
- Deas DE, Mackey SA, Sagun RS Jr, Hancock RH, Gruwell SF, Campbell CM. Crown lengthening in the maxillary anterior region: a 6-month prospective clinical study. *Int J Periodontics Restorative Dent.* 2014 May-Jun;34(3):365-73. doi: 10.11607/prd.1926. PMID: 24804287.
- Zucchelli G, Mazzotti C, Monaco C. A Standardized Approach for the Early Restorative Phase After Esthetic Crown-Lengthening Surgery. *Int J Periodontics Restorative Dent.* 2015 Sep-Oct;35(5):601-11. doi: 10.11607/prd.2444. PMID: 26357690.

12.6 Lip repositioning surgery

- Rosenblatt A, Simon Z. Lip repositioning for reduction of excessive gingival display: a clinical report. *Int J Periodontics Restorative Dent.* 2006 Oct;26(5):433-7. PMID: 17073353.
- Jacobs PJ, Jacobs BP. Lip repositioning with reversible trial for the management of excessive gingival display: a case series. *Int J Periodontics Restorative Dent.* 2013 Mar-Apr;33(2):169-75. doi: 10.11607/prd.1483. PMID: 23484172.
- Silva CO, Ribeiro-Júnior NV, Campos TV, Rodrigues JG, Tatakis DN. Excessive gingival display: treatment by a modified lip repositioning technique. *J Clin Periodontol.* 2013 Mar;40(3):260-5. doi: 10.1111/jcpe.12046. Epub 2012 Dec 20. PMID: 23278672.

4. Ribeiro-Júnior NV, Campos TV, Rodrigues JG, Martins TM, Silva CO. Treatment of excessive gingival display using a modified lip repositioning technique. *Int J Periodontics Restorative Dent.* 2013 May-Jun;33(3):309-14. doi: 10.11607/prd.1325. PMID: 23593624.
5. Silva CO, Rezende RI, Mazuquini AC, Leal VC, Amaral GSA, Guo X, Tatakis DN. Aesthetic crown lengthening and lip repositioning surgery: Pre- and post-operative assessment of smile attractiveness. *J Clin Periodontol.* 2021 Jun;48(6):826-833. doi: 10.1111/jcpe.13461. Epub 2021 Apr 6. PMID: 33745186.
6. Andijani, R. I., Paramitha, V., Guo, X., Deguchi, T., & Tatakis, D. N. (2021). Lip repositioning surgery for gummy smile: 6-month clinical and radiographic lip dimensional changes. *Clinical oral investigations*, 25(10), 5907–5915. <https://doi.org/10.1007/s00784-021-03896-7>

13. Furcation Management

13.1 Anatomy

Questions to be answered in this section:

- What is the furcation anatomy of molars?
- What are different furcation classification and management?

1. Goldman HM, et al. Management of the partial furcation involvement. *Periodontics.* 1968;6:197-206. PMID: 4879264
2. Ross IF, Thompson RH Jr. A long-term study of root retention in the treatment of maxillary molars with furcation involvement. *J Periodontol.* 1978;49:238. PMID: 277675 DOI: 10.1902/jop.1978.49.5.238
3. Bower RC. Furcation morphology relative to periodontal treatment - furcation entrance architecture. *J Periodontol.* 1979;50:23. PMID: 283222 DOI: 10.1902/jop.1979.50.1.23
4. Kalkwarf KL, Reinhardt RA. The furcation problem: Current controversies and future directions. *Dent Clin North Am.* 1988;22:243-66. PMID: 3288512
5. Kalkwarf KL, et al. Evaluation of furcation region response to periodontal therapy. *J Periodontol.* 1988;794-804. PMID: 3066889 DOI: 10.1902/jop.1988.59.12.794
6. Bower RC. Furcation morphology relative to periodontal treatment. Furcation root surface anatomy. *J Periodontol.* 1979;50:366-374. PMID: 288913 DOI: 10.1902/jop.1979.50.7.366
7. Bower RC. Furcation morphology relative to periodontal treatment. Furcation entrance architecture. *J Periodontol.* 1979;50:23-27. PMID: 283222 DOI: 10.1902/jop.1979.50.1.23
8. Gher ME, Vernino AR. Root morphology - clinical significance in pathogenesis and treatment of periodontal disease. *J Am Dent Assoc.* 1980;101:627-633. PMID: 7002975 DOI: 10.14219/jada.archive.1980.0372
9. Hermann DW, Gher ME, Dunlap RM, Pelleu GB. The potential attachment area of the maxillary first molar. *J Periodontol.* 1983;54:431-434. PMID: 6577179 DOI: 10.1902/jop.1983.54.7.431
10. Gher ME, Dunlap R. Linear variation of the root surface area of the maxillary first molar. *J Periodontol.* 1985;56:39-43. PMID: 3882932 DOI: 10.1902/jop.1985.56.1.39
11. Dunlap R, Gher M. Root surface measurements of the mandibular first molar. *J Periodontol.* 1985;56:234-238. PMID: 3858505 DOI: 10.1902/jop.1985.56.4.234
12. Booker BW, Loughlin DM. A morphologic study of the mesial root surface of the adolescent maxillary first bicuspid. *J Periodontol.* 1985;56:666-670. PMID: 3863916 DOI: 10.1902/jop.1985.56.11.666

13.2 Root Amputation & Hemisection: Rationale, Clinical Indications, & Prognosis

1. Basaraba N. Root amputation and tooth hemisection. *Dent Clin North Am.* 1969 Jan;13(1):121-32. PMID: 5249425.
2. Hamp SE, Nyman S, Lindhe J. Periodontal treatment of multirooted teeth. Results after 5 years. *J Clin Periodontol.* 1975 Aug;2(3):126-35. PMID: 1058213.
3. Langer B, Stein SD, Wagenberg B. An evaluation of root resections. A ten-year study. *J Periodontol.* 1981 Dec;52(12):719-22. PMID: 6948102.
4. Bühler H. Evaluation of root-resected teeth. Results after 10 years. *J Periodontol.* 1988 Dec;59(12):805-10. PMID: 3066890.
5. Basten CH, Ammons WF, Persson R. Long-term evaluation of root-resected molars: A retrospective study. *Int J Perio & Rest Dent.* 1996;16:207-219.
6. Carnevale G, Pontoriero R, di Febo G. Long-term effects of root-resective therapy in furcation-involved molars. A 10-year longitudinal study. *J Clin Periodontol.* 1998 Mar;25(3):209-14. PMID: 9543191.
7. Hou GL, Tsai CC, Weisgold AS. Treatment of molar furcation involvement using root separation and a crown and sleeve-coping telescopic denture. A longitudinal study. *J Periodontol.* 1999 Sep;70(9):1098-109. PMID: 10505813.
8. Svardstrom G, Wennstrom JL. Periodontal treatment decisions for molars: An analysis of influencing factors and long-term outcome. *J Periodontol.* 2000;71:579-585.
9. Fugazzotto PA. A comparison of the success of root resected molars and molar position implants in function in a private practice: results of up to 15-plus years. *J Periodontol.* 2001 Aug;72(8):1113-23. PMID: 11525447.
10. Derks H, Westheide D, Pfefferle T, Eickholz P, Dannewitz B. Retention of molars after root-resective therapy: a retrospective evaluation of up to 30 years. *Clin Oral Investig.* 2018 Apr;22(3):1327-1335. PMID: 28988369.
11. El Sayed N, Cosgarea R, Rahim S, Giess N, Krisam J, Kim TS. Patient-, tooth-, and dentist-related factors influencing long-term tooth retention after resective therapy in an academic setting - a retrospective study. *Clin Oral Investig.* 2020 Jul;24(7):2341-2349.

Reviews:

1. Basaraba N. Root amputation and tooth hemisection. *Dent Clin North Am.* 1969 Jan;13(1):121-32. PMID: 5249425.
2. Hempton T, Leone C. A review of root resective therapy as a treatment option for maxillary molars. *J Am Dent Assoc.* 1997 Apr;128(4):449-55. PMID: 9103795 DOI: 10.14219/jada.archive.1997.0229.
3. Dommisch H, Walter C, Dannewitz B, Eickholz P. Resective surgery for the treatment of furcation involvement: A systematic review. *J Clin Periodontol.* 2020 Jul;47 Suppl 22:375-391. PMID: 31912534 DOI: 10.1111/jcpe.13241.

13.3 Tunneling: Rationale, Clinical Indications, & Prognosis

1. Hellden LB, Elliot A, Steffensen B, Steffensen JE. The prognosis of tunnel preparations in treatment of class III furcations. A follow-up study. *J Periodontol.* 1989 Apr;60(4):182-7. doi: 10.1902/jop.1989.60.4.182. PMID: 2724031.
2. Rüdiger SG. Mandibular and maxillary furcation tunnel preparations--literature review and a case report. *J Clin Periodontol.* 2001 Jan;28(1):1-8. PMID: 11142660.

14. Periodontal Regeneration

Questions to be answered from this topic:

- What is the definition of periodontal regeneration?
- Describe osteogenesis, osteoinduction, osteoconduction, and bone fill.
- What are the objectives of osseous grafting?
- What are potential advantages and limitations of osseous grafting?
- What makes autogenous grafts the “gold standard”?
- Compare the different types of allografts currently used.
- What makes xenografts grafting materials unique?
- What are the most common types of alloplasts, and their indications?
- Describe the evidence on utilizing biologic agents in periodontal regeneration.
- What are the factors to consider when attempting periodontal regeneration in furcation defects?

14.1 Principles of Periodontal Regeneration: Epithelial Retardation & Guided Tissue Regeneration

1. Mayfield, L., Soderholm, G., Hallstrom, H., et al. Guided tissue regeneration for the treatment of intraosseous defects using a biabsorbable membrane. A controlled clinical study. *J Clin Periodontol* 1998;25(7):585-595. doi:10.1111/j.1600-051x.1998.tb02492.x
2. Melcher, A. H., McCulloch, C. A., Cheong, T., Nemeth, E., & Shiga, A. Cells from bone synthesize cementum-like and bone-like tissue in vitro and may migrate into periodontal ligament in vivo. *J Periodontal Res* 1987;22(3):246-247. doi:10.1111/j.1600-0765.1987.tb01579.x
3. Nyman, S., Gottlow, J., Lindhe, J., Karring, T., & Wennstrom, J. New attachment formation by guided tissue regeneration. *J Periodontal Res* 1987;22(3):252-254. doi:10.1111/j.1600-0765.1987.tb01581.x
4. Karring T, Isidor F, Nyman S, Lindhe J. New attachment formation on teeth with a reduced but healthy periodontal ligament. *J Clin Periodontol* 1985;12:51-60. doi:[10.1111/j.1600-051x.1985.tb01353.x](https://doi.org/10.1111/j.1600-051x.1985.tb01353.x)
5. Karring T, Isidor F, Nyman S, Lindhe J. New attachment formation on citric acid and non-citric acid treated roots. *J Periodontal Res* 1984;19:666-669. doi:[10.1111/j.1600-0765.1984.tb01337.x](https://doi.org/10.1111/j.1600-0765.1984.tb01337.x)

Reviews:

1. Melcher, A. H. On the repair potential of periodontal tissues. *J Periodontol* 1976;47(5):256-260. doi:10.1902/jop.1976.47.5.256
2. Position Paper: Periodontal Regeneration. *J Periodontol* 2005;76:1601-1622. doi:[10.1902/jop.2005.76.9.1601](https://doi.org/10.1902/jop.2005.76.9.1601)

14.2 Flap Designs & Suturing Techniques

1. Takei HH, Han TJ, Carranza FA, Jr., Kenney EB, Lekovic V. Flap technique for periodontal bone implants. Papilla preservation technique. *J Periodontol* 1985;56:204-210. doi:[10.1902/jop.1985.56.4.204](https://doi.org/10.1902/jop.1985.56.4.204)
2. Cortellini, P., & Bowers, G. M. Periodontal regeneration of intrabony defects: an evidence-based treatment approach. *Int J Periodontics Restorative Dent* 1995;15(2):128-145.
3. Cortellini, P., Prato, G. P., & Tonetti, M. S. The simplified papilla preservation flap. A novel surgical approach for the management of soft tissues in regenerative procedures. *Int J Periodontics Restorative Dent* 1999;19(6):589-599.
4. Cortellini, P., & Tonetti, M. S. A minimally invasive surgical technique with an enamel matrix derivative in the regenerative treatment of intra-bony defects: a novel approach to limit morbidity. *J Clin Periodontol* 2007;34(1):87-93. doi:10.1111/j.1600-051X.2006.01020.x
5. Cortellini, P., & Tonetti, M. S. Improved wound stability with a modified minimally invasive surgical ⁷⁶

technique in the regenerative treatment of isolated interdental intrabony defects. *J Clin Periodontol* 2009;36(2):157-163. doi:10.1111/j.1600-051X.2008.01352.x

6. Cortellini, P., & Tonetti, M. S. Clinical and radiographic outcomes of the modified minimally invasive surgical technique with and without regenerative materials: a randomized-controlled trial in intra-bony defects. *J Clin Periodontol* 2011;38(4):365-373. doi:10.1111/j.1600-051X.2011.01705.x

7. Schincaglia GP, Hebert E, Farina R, Simonelli A, Trombelli L. Single versus double flap approach in periodontal regenerative treatment. *J Clin Periodontol* 2015;42:557-566. doi:[10.1111/jcpe.12409](https://doi.org/10.1111/jcpe.12409)

8. Farina R, Simonelli A, Rizzi A, Pramstraller M, Cucchi A, Trombelli L. Early postoperative healing following buccal single flap approach to access intraosseous periodontal defects. *Clin Oral Investig* 2013;17:1573-1583. doi:[10.1007/s00784-012-0838-6](https://doi.org/10.1007/s00784-012-0838-6)

9. Trombelli L, Simonelli A, Quaranta A, et al. Effect of Flap Design for Enamel Matrix Derivative Application in Intraosseous Defects. *JDR Clin Trans Res* 2021;6:184-194. doi:[10.1177/2380084420934731](https://doi.org/10.1177/2380084420934731)

10. Aslan S, Buduneli N, Cortellini P. Entire Papilla Preservation Technique: A Novel Surgical Approach for Regenerative Treatment of Deep and Wide Intrabony Defects. *Int J Periodontics Restorative Dent* 2017;37:227-233. doi:[10.11607/prd.2584](https://doi.org/10.11607/prd.2584)

11. Aslan S, Buduneli N, Cortellini P. Entire papilla preservation technique in the regenerative treatment of deep intrabony defects: 1-Year results. *J Clin Periodontol* 2017;44:926-932. doi:[10.1111/jcpe.12780](https://doi.org/10.1111/jcpe.12780)

12. Cortellini P, Pini Prato G, Tonetti MS. Periodontal regeneration of human intrabony defects with titanium reinforced membranes. A controlled clinical trial. *J Periodontol* 1995;66:797-803. doi:[10.1902/jop.1995.66.9.797](https://doi.org/10.1902/jop.1995.66.9.797)

13. Tonetti MS, Cortellini P, Lang NP, et al. Clinical outcomes following treatment of human intrabony defects with GTR/bone replacement material or access flap alone. A multicenter randomized controlled clinical trial. *J Clin Periodontol* 2004;31:770-776. doi:[10.1111/j.1600-051X.2004.00562.x](https://doi.org/10.1111/j.1600-051X.2004.00562.x)

14.3 - Microsurgery:

1. Shanelic DA, Tibbetts LS. A perspective on the future of periodontal microsurgery. *Periodontol 2000* 1996;11:58-64. doi:[10.1111/j.1600-0757.1996.tb00183.x](https://doi.org/10.1111/j.1600-0757.1996.tb00183.x)

2. Rodriguez A, Velasquez D, Chan HL. Review of Intraoral Vasculature and Implications on Incision Designs of Periodontal and Implant Surgeries. *Int J Periodontics Restorative Dent* 2023;43:753-761. doi:[10.11607/prd.6213](https://doi.org/10.11607/prd.6213)

14.4 Graft Types: Autografts, Allografts, Xenografts, & Alloplasts

1. Buck, B. E., Resnick, L., Shah, S. M., & Malinin, T. I. Human immunodeficiency virus cultured from bone. Implications for transplantation. *Clin Orthop Relat Res* 1990;251:249-253. PMID: 2295182

2. Hiatt, W. H., & Schallhorn, R. G. Intraoral transplants of cancellous bone and marrow in periodontal lesions. *J Periodontol* 1973;44(4):194-208. doi:[10.1902/jop.1973.44.4.194](https://doi.org/10.1902/jop.1973.44.4.194)

3. Mellonig, J. T. Decalcified freeze-dried bone allograft as an implant material in human periodontal defects. *Int J Periodontics Restorative Dent* 1984;4(6):40-55. PMID: 6396269

4. Richardson, C. R., Mellonig, J. T., Brunsvold, M. A., McDonnell, H. T., & Cochran, D. L. Clinical evaluation of Bio-Oss: a bovine-derived xenograft for the treatment of periodontal osseous defects in humans. *J Clin* 77

Periodontol 1999;26(7):421-428. doi:10.1034/j.1600-051x.1999.260702.x

5. Schallhorn, R. G., & Hiatt, W. H. Human allografts of iliac cancellous bone and marrow in periodontal osseous defects. II. Clinical observations. *J Periodontol* 1972;43(2):67-81. doi:10.1902/jop.1972.43.2.67
6. Stahl, S. S., & Froum, S. J. Histologic and clinical responses to porous hydroxylapatite implants in human periodontal defects. Three to twelve months postimplantation. *J Periodontol* 1987;58(10):689-695. doi:10.1902/jop.1987.58.10.689
7. Urist, M. R., & Strates, B. S. Bone formation in implants of partially and wholly demineralized bone matrix. Including observations on acetone-fixed intra and extracellular proteins. *Clin Orthop Relat Res* 1970;71:271-278. PMID: 5433388
8. Bowers, G. M., Chadroff, B., Carnevale, R., Mellonig, J., Corio, R., Emerson, J., . . . Romberg, E.. Histologic evaluation of new attachment apparatus formation in humans. Part I. *J Periodontol* 1989;60(12):664-674. doi:10.1902/jop.1989.60.12.664
9. Bowers, G. M., Chadroff, B., Carnevale, R., Mellonig, J., Corio, R., Emerson, J., . . . Romberg, E. Histologic evaluation of new attachment apparatus formation in humans. Part II. *J Periodontol* 1989;60(12):675-682. doi:10.1902/jop.1989.60.12.675
10. Bowers, G. M., Chadroff, B., Carnevale, R., Mellonig, J., Corio, R., Emerson, J., . . . Romberg, E. Histologic evaluation of new attachment apparatus formation in humans. Part III. *J Periodontol* 1989;60(12):683-693. doi:10.1902/jop.1989.60.12.683
11. Ong MM, Eber RM, Korsnes MI, et al. Evaluation of a bioactive glass alloplast in treating periodontal intrabony defects. *J Periodontol* 1998;69:1346-1354. doi:[10.1902/jop.1998.69.12.1346](https://doi.org/10.1902/jop.1998.69.12.1346)
12. Dragoo MR, Kaldahl WB. Clinical and histological evaluation of alloplasts and allografts in regenerative periodontal surgery in humans. *Int J Periodontics Restorative Dent* 1983;3:8-29. PMID: 6358082

Reviews:

1. Mellonig, J. T. Freeze-dried bone allografts in periodontal reconstructive surgery. *Dent Clin North Am* 1991;35(3):505-520. PMID: 1879574
2. Mellonig, J. T. Autogenous and allogeneic bone grafts in periodontal therapy. *Crit Rev Oral Biol Med* 1992;3(4):333-352. doi:10.1177/10454411920030040201
3. Rosenberg, E., & Rose, L. F. Biologic and clinical considerations for autografts and allografts in periodontal regeneration therapy. *Dent Clin North Am* 1998;42(3):467-490. PMID: 9700450

14.5 Absorbable and non-resorbable membranes

1. Brunel, G., Piantoni, P., Elharar, F., Benque, E., Marin, P., & Zahedi, S. Regeneration of rat calvarial defects using a bioabsorbable membrane technique: influence of collagen cross-linking. *J Periodontol* 1996;67(12):1342-1348. doi:10.1902/jop.1996.67.12.1342
2. Cortellini, P., Paolo, G., Prato, P., & Tonetti, M. S. Long-term stability of clinical attachment following guided tissue regeneration and conventional therapy. *J Clin Periodontol* 1996;23(2):106-111.

doi:10.1111/j.1600-051x.1996.tb00542.x

3. Nyman, S., Gottlow, J., Lindhe, J., Karring, T., & Wennstrom, J. New attachment formation by guided tissue regeneration. *J Periodontal Res* 1987;22(3):252-254. doi:10.1111/j.1600-0765.1987.tb01581.x
4. Tonetti, M. S., Prato, G. P., & Cortellini, P. Factors affecting the healing response of intrabony defects following guided tissue regeneration and access flap surgery. *J Clin Periodontol* 1996;23(6):548-556. doi:10.1111/j.1600-051x.1996.tb01823.x
5. Nowzari H, Matian F, Slots J. Periodontal pathogens on polytetrafluoroethylene membrane for guided tissue regeneration inhibit healing. *J Clin Periodontol* 1995;22:469-474. doi:[10.1111/j.1600-051x.1995.tb00179.x](https://doi.org/10.1111/j.1600-051x.1995.tb00179.x)
6. Nowzari H, Slots J. Microorganisms in polytetrafluoroethylene barrier membranes for guided tissue regeneration. *J Clin Periodontol* 1994;21:203-210. doi:[10.1111/j.1600-051x.1994.tb00305.x](https://doi.org/10.1111/j.1600-051x.1994.tb00305.x)

14.6 Biologics, growth factors, and stem cells

1. Nevins, M., Giannobile, W. V., McGuire, M. K., Kao, R. T., Mellonig, J. T., Hinrichs, J. E., . . . Lynch, S. E. Platelet-derived growth factor stimulates bone fill and rate of attachment level gain: results of a large multicenter randomized controlled trial. *J Periodontol* 2005;76(12):2205-2215. doi:10.1902/jop.2005.76.12.2205
2. Sculean, A., Kiss, A., Miliauskaite, A., Schwarz, F., Arweiler, N. B., & Hannig, M. Ten-year results following treatment of intra-bony defects with enamel matrix proteins and guided tissue regeneration. *J Clin Periodontol* 2008;35(9):817-824. doi:10.1111/j.1600-051X.2008.01295.x
3. Siciliano, V. I., Andreuccetti, G., Siciliano, A. I., Blasi, A., Sculean, A., & Salvi, G. E. Clinical outcomes after treatment of non-contained intrabony defects with enamel matrix derivative or guided tissue regeneration: a 12-month randomized controlled clinical trial. *J Periodontol* 2011;82(1):62-71. doi:10.1902/jop.2010.100144
4. Tonetti, M. S., Lang, N. P., Cortellini, P., et al. Enamel matrix proteins in the regenerative therapy of deep intrabony defects. *J Clin Periodontol* 2002;29(4):317-325. doi:10.1034/j.1600-051x.2002.290407.x
5. Kobayashi E, Fluckiger L, Fujioka-Kobayashi M, et al. Comparative release of growth factors from PRP, PRF, and advanced-PRF. *Clin Oral Investig* 2016;20:2353-2360. doi:[10.1007/s00784-016-1719-1](https://doi.org/10.1007/s00784-016-1719-1)

Reviews:

1. Miron RJ, Fujioka-Kobayashi M, Bishara M, Zhang Y, Hernandez M, Choukroun J. Platelet-Rich Fibrin and Soft Tissue Wound Healing: A Systematic Review. *Tissue Eng Part B Rev* 2017;23:83-99. doi:[10.1089/ten.TEB.2016.0233](https://doi.org/10.1089/ten.TEB.2016.0233)
2. Tavelli L, Chen CJ, Barootchi S, Kim DM. Efficacy of biologics for the treatment of periodontal infrabony defects: An American Academy of Periodontology best evidence systematic review and network meta-analysis. *J Periodontol* 2022;93:1803-1826. doi:[10.1002/JPER.22-0120](https://doi.org/10.1002/JPER.22-0120)
3. Avila-Ortiz G, Ambruster J, Barootchi S, et al. American Academy of Periodontology best evidence consensus statement on the use of biologics in clinical practice. *J Periodontol* 2022;93:1763-1770. doi:[10.1002/JPER.22-0361](https://doi.org/10.1002/JPER.22-0361)

14.7 Intrabony Defects: Considerations and Outcomes

1. Mayfield, L., Soderholm, G., Hallstrom, H., Kullendorff, B., Edwardsson, S., Bratthall, G., Brägger, U., Attstrom, R. Guided tissue regeneration for the treatment of intraosseous defects using a biabsorbable membrane. A controlled clinical study. *J Clin Periodontol* 1998;25(7):585-595. doi:10.1111/j.1600-051x.1998.tb02492.x
2. Tonetti, M. S., Prato, G. P., & Cortellini, P. Factors affecting the healing response of intrabony defects following guided tissue regeneration and access flap surgery. *J Clin Periodontol* 1996;23(6):548-556. doi:10.1111/j.1600-051x.1996.tb01823.x
3. Steffensen B, Webert HP. Relationship between the radiographic periodontal defect angle and healing after treatment. *J Periodontol* 1989;60:248-254. doi:[10.1902/jop.1989.60.5.248](https://doi.org/10.1902/jop.1989.60.5.248)
4. Cortellini P, Stalpers G, Mollo A, Tonetti MS. Periodontal regeneration versus extraction and prosthetic replacement of teeth severely compromised by attachment loss to the apex: 5-year results of an ongoing randomized clinical trial. *J Clin Periodontol* 2011;38:915-924. doi:[10.1111/j.1600-051X.2011.01768.x](https://doi.org/10.1111/j.1600-051X.2011.01768.x)
5. Aimetti M, Romano F, Pigella E, Pranzini F, Debernardi C. Treatment of wide, shallow, and predominantly 1-wall intrabony defects with a bioabsorbable membrane: a randomized controlled clinical trial. *J Periodontol* 2005;76:1354-1361. doi:[10.1902/jop.2005.76.8.1354](https://doi.org/10.1902/jop.2005.76.8.1354)

Reviews:

1. Laurell, L., Gottlow, J., Zybutz, M., & Persson, R. Treatment of intrabony defects by different surgical procedures. A literature review. *J Periodontol* 1998;69(3):303-313. doi:10.1902/jop.1998.69.3.303
2. Mellonig, J. T. Freeze-dried bone allografts in periodontal reconstructive surgery. *Dent Clin North Am* 1991;35(3):505-520. PMID: 1879574
3. Mellonig, J. T. Autogenous and allogeneic bone grafts in periodontal therapy. *Crit Rev Oral Biol Med* 1992;3(4):333-352. doi:10.1177/10454411920030040201
4. Murphy, K. G., & Gunsolley, J. C. Guided tissue regeneration for the treatment of periodontal intrabony and furcation defects. A systematic review. *Ann Periodontol* 2003;8(1):266-302. doi:10.1902/annals.2003.8.1.266
5. Reynolds MA, Kao RT, Camargo PM, et al. Periodontal regeneration - intrabony defects: a consensus report from the AAP Regeneration Workshop. *J Periodontol* 2015;86:S105-107. doi:[10.1902/jop.2015.140378](https://doi.org/10.1902/jop.2015.140378)

14.8 Furcation defects: considerations and outcomes

1. Pontoriero, R., & Lindhe, J. Guided tissue regeneration in the treatment of degree II furcations in maxillary molars. *J Clin Periodontol* 1995;22(10):756-763. doi:10.1111/j.1600-051x.1995.tb00258.x
2. Pontoriero, R., Lindhe, J., Nyman, S., Karring, T., Rosenberg, E., & Sanavi, F. Guided tissue regeneration in degree II furcation-involved mandibular molars. A clinical study. *J Clin Periodontol* 1988;15(4):247-254. doi:10.1111/j.1600-051x.1988.tb01578.x
3. Pontoriero, R., Lindhe, J., Nyman, S., Karring, T., Rosenberg, E., & Sanavi, F. Guided tissue regeneration in the treatment of furcation defects in mandibular molars. A clinical study of degree III involvements. *J Clin Periodontol* 1989;16(3):170-174. doi:10.1111/j.1600-051x.1989.tb01635.x

4. Machtei EE, Schallhorn RG. Successful regeneration of mandibular Class II furcation defects: an evidence-based treatment approach. *Int J Periodontics Restorative Dent* 1995;15:146-167. PMID: 8593980
5. Bowers GM, Schallhorn RG, McClain PK, Morrison GM, Morgan R, Reynolds MA. Factors influencing the outcome of regenerative therapy in mandibular Class II furcations: Part I. *J Periodontol* 2003;74:1255-1268. doi:[10.1902/jop.2003.74.9.1255](https://doi.org/10.1902/jop.2003.74.9.1255)
6. Reddy MS, Aichelmann-Reidy ME, Avila-Ortiz G, et al. Periodontal regeneration - furcation defects: a consensus report from the AAP Regeneration Workshop. *J Periodontol* 2015;86:S131-133. doi:[10.1902/jop.2015.140379](https://doi.org/10.1902/jop.2015.140379)
7. Jepsen S, Heinz B, Jepsen K, et al. A randomized clinical trial comparing enamel matrix derivative and membrane treatment of buccal Class II furcation involvement in mandibular molars. Part I: Study design and results for primary outcomes. *J Periodontol* 2004;75:1150-1160. doi:[10.1902/jop.2004.75.8.1150](https://doi.org/10.1902/jop.2004.75.8.1150)
8. Meyle J, Gonzales JR, Bodeker RH, et al. A randomized clinical trial comparing enamel matrix derivative and membrane treatment of buccal class II furcation involvement in mandibular molars. Part II: secondary outcomes. *J Periodontol* 2004;75:1188-1195. doi:[10.1902/jop.2004.75.9.1188](https://doi.org/10.1902/jop.2004.75.9.1188)

Reviews:

1. Avila-Ortiz, G., De Buitrago, J. G., & Reddy, M. S. Periodontal regeneration - furcation defects: a systematic review from the AAP Regeneration Workshop. *J Periodontol* 2015;86(2 Suppl):S108-130. doi:[10.1902/jop.2015.130677](https://doi.org/10.1902/jop.2015.130677)
2. Jepsen S, Eberhard J, Herrera D, Needleman I. A systematic review of guided tissue regeneration for periodontal furcation defects. What is the effect of guided tissue regeneration compared with surgical debridement in the treatment of furcation defects? *J Clin Periodontol* 2002;29 Suppl 3:103-116; discussion 160-162. doi:[10.1034/j.1600-051x.29.s3.6.x](https://doi.org/10.1034/j.1600-051x.29.s3.6.x)
3. Jepsen S, Gennai S, Hirschfeld J, Kalemaj Z, Buti J, Graziani F. Regenerative surgical treatment of furcation defects: A systematic review and Bayesian network meta-analysis of randomized clinical trials. *J Clin Periodontol* 2020;47 Suppl 22:352-374. doi:[10.1111/jcpe.13238](https://doi.org/10.1111/jcpe.13238)

15. Periodontal Plastic Surgery

Questions to be answered from this topic:

- What are the potential etiologies for gingival recessions?
- How to make a diagnosis for gingival recessions?
- Is there a minimum amount of attached gingiva required to maintain gingival health?
- What is Miller's classification of soft tissue recession?
- What is Sullivan and Atkins classification of gingival recession?
- How much shrinkage can occur after placing the gingival graft on denuded bone and periosteum?
- What is the influence of root conditioning on root coverage outcomes?
- Why is “connective tissue graft” considered the gold standard for root coverage procedures?
- What is the currently available evidence of using allograft, xenograft or biologic agents for root coverage procedures?
- What is the classification and proposed treatments for non-carious cervical lesions?

15.1 Gingival recession: etiology, diagnosis, and prognosis

1. Hall, W.B. Present Status of Soft Tissue Grafting. *J Periodontol* 1977;48:587-597. doi:<https://doi.org/10.1902/jop.1977.48.9.587>

2. Chambrone, L., & Tatakis, D. N. Periodontal soft tissue root coverage procedures: a systematic review from the AAP Regeneration Workshop. *J Periodontol* 2015;86:S8-S51. <https://doi.org/10.1902/jop.2015.130674>
3. Cortellini, P, Bissada, NF. Mucogingival conditions in the natural dentition: Narrative review, case definitions, and diagnostic considerations. *J Periodontol* 2018;89(Suppl 1): S204-S213. <https://doi.org/10.1002/JPER.16-0671>
4. Greenwell 2005. Research S, Therapy Committee of the American Academy of Periodontology. Informational Paper: Oral Reconstructive and Corrective Considerations in Periodontal Therapy. *J Periodontol* 2005;76:1588-1600. <https://doi.org/10.1902/jop.2003.74.8.1237>
5. Agudio G, Cortellini P, Buti J, Pini Prato G. Periodontal Conditions of Sites Treated With Gingival Augmentation Surgery Compared With Untreated Contralateral Homologous Sites: An 18- to 35-Year Long-Term Study. *J Periodontol* 2016;87:1371-1378. <https://doi.org/10.1902/jop.2016.160284>

15.2 Gingival recession: classifications

1. Miller, P. D. A classification of marginal tissue recession. *Int J Periodontics Restorative Dent* 1985;5:8-13. PMID: 3858267
2. Sullivan HC, Atkins JH. Free autogenous gingival grafts. 3. Utilization of grafts in the treatment of gingival recession. *Periodontics* 1968;6(4):152-60. PMID: 5243142
3. Cairo, F., Nieri, M., Cincinelli, S., Mervelt, J., & Pagliaro, U. The interproximal clinical attachment level to classify gingival recessions and predict root coverage outcomes: an explorative and reliability study. *J Clin Periodontol* 2011;38(7):661-666. <https://doi.org/10.1111/j.1600-051X.2011.01732.x>

15.3 Periodontal plastic surgery: clinical indications and rationale

1. Kennedy, J.E., Bird, W.C., Palcanis, K.G. and Dorfman, H.S. A longitudinal evaluation of varying widths of attached gingiva. *J Clin Periodontol* 1985;12:667-675. <https://doi.org/10.1111/j.1600-051X.1985.tb00938.x>
2. Miller, P.D. Root Coverage with the Free Gingival Graft. *J Periodontol* 1987;58:674-681. <https://doi.org/10.1902/jop.1987.58.10.674>
3. Chambrone, L., & Tatakis, D. N. Periodontal soft tissue root coverage procedures: a systematic review from the AAP Regeneration Workshop. *J Periodontol* 2015;86, S8-S51. <https://doi.org/10.1902/jop.2015.130674>
4. Cortellini, P, Bissada, NF. Mucogingival conditions in the natural dentition: Narrative review, case definitions, and diagnostic considerations. *J Periodontol* 2018; 89(Suppl 1): S204– S213. <https://doi.org/10.1002/JPER.16-0671>

15.4 Short and long-term outcomes including controversies on keratinized gingiva

1. Lang, N. P., & Löe, H. The relationship between the width of keratinized gingiva and gingival health. *J Periodontol* 1972;43(10):623-627. <https://doi.org/10.1902/jop.1972.43.10.623>
2. Maynard JG Jr, Wilson RD. Physiologic dimensions of the periodontium significant to the restorative dentist. *J Periodontol* 1979;50(4):170-174. <https://doi.org/10.1902/jop.1979.50.4.170>
3. Miyasato, M., Crigger, M. and Egelberg, J. Gingival condition in areas of minimal and appreciable width of keratinized gingival. *J Clin Periodontol* 1977;4:200-209. <https://doi.org/10.1111/j.1600-051X.1977.tb02273.x>

4. Dorfman, H.S., Kennedy, J.E. and Bird, W.C. Longitudinal Evaluation of Free Autogenous Gingival Grafts: A Four Year Report. *J Periodontol* 1982;53: 349-352. <https://doi.org/10.1902/jop.1982.53.6.349>
5. Kennedy, J.E., Bird, W.C., Palcanis, K.G. and Dorfman, H.S. A longitudinal evaluation of varying widths of attached gingiva. *J Clin Periodontol* 1985;12:667-675. <https://doi.org/10.1111/j.1600-051X.1985.tb00938.x>

15.5 Root surface conditioning

1. Mariotti A. Efficacy of chemical root surface modifiers in the treatment of periodontal disease. A systematic review. *Ann Periodontol* 2003;8(1):205–226. <https://doi.org/10.1902/annals.2003.8.1.205>
2. Sculean, A., Berakdar, M., Willershausen, B., Arweiler, N. B., Becker, J., & Schwarz, F. Effect of EDTA root conditioning on the healing of intrabony defects treated with an enamel matrix protein derivative. *J Periodontol* 2006;77(7):1167–1172. <https://doi.org/10.1902/jop.2006.050300>
3. Chambrone, L., & Tatakis, D. N. Periodontal soft tissue root coverage procedures: a systematic review from the AAP Regeneration Workshop. *J Periodontol* 2015;86:S8-S51. <https://doi.org/10.1902/jop.2015.130674>
4. Barootchi S, Tavelli L, Ravida A, Wang CW, Wang HL. Effect of EDTA root conditioning on the outcome of coronally advanced flap with connective tissue graft: a systematic review and meta-analysis. *Clin Oral Investig* 2018;22:2727-2741. <https://doi.org/10.1007/s00784-018-2635-3>

15.6 Frenectomy; frenulectomy; vestibular considerations

1. Bohannan, H.M. Studies in the Alteration of Vestibular Depth I. Complete Denudation. *J Periodontol* 1962;33:120-128. <https://doi.org/10.1902/jop.1962.33.2.120>
2. Blasi G, Monje A, Munoz-Penalver J, Oates TW, Avila-Ortiz G, Nart J. Influence of vestibular depth on the outcomes of root coverage therapy: A prospective case series study. *J Periodontol* 2022;93:1857-1866. <https://doi.org/10.1002/JPER.21-0638>

15.7 Coronally advanced flaps

1. Bernimoulin, J. P., Lüscher, B., & Mühlmann, H. R. Coronally repositioned periodontal flap. Clinical evaluation after one year. *J Clin Periodontol* 1975;2(1):1–13. <https://doi.org/10.1111/j.1600-051x.1975.tb01721.x>
2. Caffesse, R. G., & Guinard, E. A. Treatment of localized gingival recessions. Part II. Coronally repositioned flap with a free gingival graft. *J Periodontol* 1978;49(7):357–361. <https://doi.org/10.1902/jop.1978.49.7.357>
3. Tarnow D. P. Semilunar coronally repositioned flap. *J Clin Periodontol* 1986;13(3):182–185. <https://doi.org/10.1111/j.1600-051x.1986.tb01456.x>
4. Zabalegui, I., Sicilia, A., Cambra, J., Gil, J., & Sanz, M. Treatment of multiple adjacent gingival recessions with the tunnel subepithelial connective tissue graft: a clinical report. *Int J Periodontics Restorative Dent* 1999;19(2):199–206. PMID: 10635186
5. Pini Prato G, Pagliaro U, Baldi C, et al. Coronally advanced flap procedure for root coverage. Flap with tension versus flap without tension: a randomized controlled clinical study. *J Periodontol* 2000;71:188-201. <https://doi.org/10.1902/jop.2000.71.2.188>

15.8 Laterally repositioned flap

1. Grupe, H.E. and Warren, R.F. Repair of Gingival Defects by a Sliding Flap Operation. *J Periodontol* 1956;27:92-95. <https://doi.org/10.1902/jop.1956.27.2.92>

2. Cohen, D.W. and Ross, S.E. The Double Papillae Repositioned Flap in Periodontal Therapy. *J Periodontol* 1968;39:65-70. <https://doi.org/10.1902/jop.1968.39.2.65>
3. Harris R. J. The connective tissue and partial thickness double pedicle graft: a predictable method of obtaining root coverage. *J Periodontol* 1992;63(5):477–486. <https://doi.org/10.1902/jop.1992.63.5.477>

15.9 Free gingival tissue grafts

1. Gordon, H. P., Sullivan, H. C., & Atkins, J. H. Free autogenous gingival grafts. II. Supplemental findings—histology of the graft site. *Periodontics* 1968;6(3):130–133. PMID: 5241945
2. Oliver, R. C., Löe, H., & Karring, T. Microscopic evaluation of the healing and revascularization of free gingival grafts. *J Periodontal Res* 1968;3(2):84–95. <https://doi.org/10.1111/j.1600-0765.1968.tb01908.x>
3. Caffesse, R. G., Burgett, F. G., Nasjleti, C. E., & Castelli, W. A. Healing of free gingival grafts with and without periosteum. Part I. Histologic evaluation. *J Periodontal* 1979;50(11):586–594. <https://doi.org/10.1902/jop.1979.50.11.586>
4. Soehren, S. E., Allen, A. L., Cutright, D. E., & Seibert, J. S. Clinical and histologic studies of donor tissues utilized for free grafts of masticatory mucosa. *J Periodontal* 1973;44(12):727–741. <https://doi.org/10.1902/jop.1973.44.12.727>
5. Mörmann, W., Schaer, F., & Firestone, A. R. The relationship between success of free gingival grafts and transplant thickness. Revascularization and shrinkage—a one year clinical study. *J Periodontal* 1981;52(2):74–80. <https://doi.org/10.1902/jop.1981.52.2.74>
6. Matter J. Creeping attachment of free gingival grafts. A five-year follow-up study. *J Periodontal* 1980;51(12):681–685. <https://doi.org/10.1902/jop.1980.51.12.681>

15.10 Connective Tissue Grafts / Bilaminar Approaches

1. Langer, B., & Langer, L. Subepithelial connective tissue graft technique for root coverage. *J Periodontol* 1985;56(12):715–720. <https://doi.org/10.1902/jop.1985.56.12.715>
2. Raetzke P. B. Covering localized areas of root exposure employing the "envelope" technique. *J Periodontol* 1985;56(7):397–402. <https://doi.org/10.1902/jop.1985.56.7.397>
3. Allen A. L. Use of the supraperiosteal envelope in soft tissue grafting for root coverage. I. Rationale and technique. *Int J Periodontics Restorative Dent* 1994;14(3):216–227. PMID: 7995692
4. Reiser, G. M., Bruno, J. F., Mahan, P. E., & Larkin, L. H. The subepithelial connective tissue graft palatal donor site: anatomic considerations for surgeons. *Int J Periodontics Restorative Dent* 1996;16(2):130–137. PMID: 9084301
5. Harris R. J. Successful root coverage: a human histologic evaluation of a case. *Int J Periodontics Restorative Dent* 1999;19(5):439–447. PMID: 10709509
6. Bruno, J. F., & Bowers, G. M. Histology of a human biopsy section following the placement of a subepithelial connective tissue graft. *Int J Periodontics Restorative Dent* 2000;20(3):225–231. PMID: 11203564
7. Zucchelli, G., Gori, G., Mele, M., Stefanini, M., Mazzotti, C., Marzadori, M., Montebugnoli, L., & De Sanctis, M. Non-carious cervical lesions associated with gingival recessions: a decision-making process. *J Periodontol* 2011;82(12):1713–1724. <https://doi.org/10.1902/jop.2011.110080>
8. Chambrone, L., & Tatakis, D. N. Periodontal soft tissue root coverage procedures: a systematic review from the AAP Regeneration Workshop. *J Periodontol* 2015;86(2 Suppl):S8–S51. <https://doi.org/10.1902/jop.2015.130674>
9. Harris RJ. Creeping attachment associated with the connective tissue with partial-thickness double pedicle graft. *J Periodontol* 1997;68:890-899. <http://doi.org/10.1902/jop.1997.68.9.890>

15.11 Graft-harvesting techniques

1. Langer, B., & Langer, L. Subepithelial connective tissue graft technique for root coverage. *J Periodontol* 1985;56(12):715–720. <https://doi.org/10.1902/jop.1985.56.12.715>
2. Bruno J. F. Connective tissue graft technique assuring wide root coverage. *Int J Periodontics Restorative Dent* 1994;14(2):126–137. PMID: 7928129

15.12 Guided tissue regeneration

1. Pini Prato, G., Tinti, C., Vincenzi, G., Magnani, C., Cortellini, P., & Clauser, C. Guided tissue regeneration versus mucogingival surgery in the treatment of human buccal gingival recession. *J Periodontol* 1992;63(11):919–928. <https://doi.org/10.1902/jop.1992.63.11.919>
2. Pini Prato, G., Clauser, C., Cortellini, P., Tinti, C., Vincenzi, G., & Pagliaro, U. Guided tissue regeneration versus mucogingival surgery in the treatment of human buccal recessions. A 4-year follow-up study. *J Periodontol* 1996;67(11):1216–1223. <https://doi.org/10.1902/jop.1996.67.11.1216>
3. Nickles, K., Ratka-Krüger, P., Neukranz, E., Raetzke, P., & Eickholz, P. Ten-year results after connective tissue grafts and guided tissue regeneration for root coverage. *J Periodontol* 2010;81(6):827–836. <https://doi.org/10.1902/jop.2010.090632>

15.13 Allografts, xenografts, and biologics

1. Allen E. P. Subpapillary continuous sling suturing method for soft tissue grafting with the tunneling technique. *Int J Periodontics Restorative Dent* 2010;30(5):479–485. PMID: 20814601
2. Chambrone, L., Barootchi, S., & Avila-Ortiz, G. (2022). Efficacy of biologics in root coverage and gingival augmentation therapy: An American Academy of Periodontology best evidence systematic review and network meta-analysis. *J Periodontol* 2022;93(12):1771–1802. <https://doi.org/10.1002/JPER.22-0075>
3. Harris R. J. A short-term and long-term comparison of root coverage with an acellular dermal matrix and a subepithelial graft. *J Periodontol* 2004;75(5):734–743. <https://doi.org/10.1902/jop.2004.75.5.734>
4. Henderson, R. D., Greenwell, H., Drisko, C., Regennitter, F. J., Lamb, J. W., Mehlbauer, M. J., Goldsmith, L. J., & Rebitzki, G. Predictable multiple site root coverage using an acellular dermal matrix allograft. *J Periodontol* 2001;72(5):571–582. <https://doi.org/10.1902/jop.2001.72.5.571>
5. Koop, R., Merheb, J., & Quirynen, M. Periodontal regeneration with enamel matrix derivative in reconstructive periodontal therapy: a systematic review. *J Periodontol* 2012;83(6):707–720. <https://doi.org/10.1902/jop.2011.110266>
6. McGuire, M. K., & Scheyer, E. T. Randomized, controlled clinical trial to evaluate a xenogeneic collagen matrix as an alternative to free gingival grafting for oral soft tissue augmentation. *J Periodontol* 2014;85(10):1333–1341. <https://doi.org/10.1902/jop.2014.130692>
7. McGuire, M. K., Scheyer, E. T., & Snyder, M. B. Evaluation of recession defects treated with coronally advanced flaps and either recombinant human platelet-derived growth factor-BB plus β-tricalcium phosphate or connective tissue: comparison of clinical parameters at 5 years. *J Periodontol* 2014;85(10):1361–1370. <https://doi.org/10.1902/jop.2014.140006>
8. Wei, P. C., Laurell, L., Geivelis, M., Lingen, M. W., & Maddalozzo, D. Acellular dermal matrix allografts to achieve increased attached gingiva. Part 1. A clinical study. *J Periodontol* 2000;71(8):1297–1305. <https://doi.org/10.1902/jop.2000.71.8.1297>

9. Woodyard, J. G., Greenwell, H., Hill, M., Drisko, C., Iasella, J. M., & Scheetz, J. The clinical effect of acellular dermal matrix on gingival thickness and root coverage compared to coronally positioned flap alone. *J Periodontol* 2004;75(1):44–56. <https://doi.org/10.1902/jop.2004.75.1.44>

15.14 Non-carious cervical lesions

1. Grippo, J. O., Simring, M., & Schreiner, S. Attrition, abrasion, corrosion and abfraction revisited: a new perspective on tooth surface lesions. *J Am Dent Assoc* 2004;135(8):1109–1165. <https://doi.org/10.14219/jada.archive.2004.0369>
2. Zucchelli, G., Gori, G., Mele, M., Stefanini, M., Mazzotti, C., Marzadori, M., Montebugnoli, L., & De Sanctis, M. Non-carious cervical lesions associated with gingival recessions: a decision-making process. *J Periodontol* 2011;82(12):1713–1724. <https://doi.org/10.1902/jop.2011.110080>

16. Wound healing

16.1 Wound healing: non-surgical therapy

1. Aleo JJ, De Renzis FA, Farber PA. In vitro attachment of human gingival fibroblasts to root surfaces. *J Periodontol.* 1975;46:639-645.
2. Waerhaug J. Healing of the dento-epithelial junction following subgingival plaque control. I. As observed in human biopsy material. *J Periodontol.* 1978 Jan;49(1):1-8. PMID: 340634 DOI: 10.1902/jop.1978.49.1.1.
3. Waerhaug J. Healing of the dento-epithelial junction following subgingival plaque control. II: As observed on extracted teeth. *J Periodontol.* 1978 Mar;49(3):119-34. PMID: 288899 DOI: 10.1902/jop.1978.49.3.119.
4. Caton JG, Zander HA. The attachment between tooth and gingival tissues after periodic root planing and soft tissue curettage. *J Periodontol.* 1979 Sep;50(9):462-6. PMID: 114618 DOI: 10.1902/jop.1979.50.9.462.
5. Lindhe J, Westfelt E, Nyman S, Socransky SS, Heijl L, Brathall G. Healing following surgical/non-surgical treatment of periodontal disease. A clinical study. *J Clin Periodontol.* 1982 Mar;9(2):115-28. PMID: 7042768 DOI: 10.1111/j.1600-051x.1982.tb01227.x.
6. Polson AM, Caton J. Factors influencing periodontal repair and regeneration. *J Periodontol.* 1982 Oct;53(10):617-25. PMID: 6958856 DOI: 10.1902/jop.1982.53.10.617.
7. Wilson TG, Carnio J, Schenk R, Myers G. Absence of histologic signs of chronic inflammation following closed subgingival scaling and root planning using the dental endoscope: human biopsies - a pilot study. *J Periodontol.* 2008;79(11):2036-41.

16.2 Wound healing: periodontal resective surgery

Questions to be answered from this topic:

- What happens to the osseous crest level after the resective surgical procedure?
 - What type of healing happens after osseous surgery in histologic evaluation for epithelial attachment?
 - What type of healing happens after osseous surgery in histologic evaluation for connective tissue attachment?
1. Wilderman MN, Pennel BM, King K, Barron JM. Histogenesis of repair following osseous surgery. *J Periodontol.* 1970 Oct;41(10):551-65. PMID: 4918577 DOI: 10.1902/jop.1970.41.10.551.

2. Wood DL, Hoag PM, Donnenfeld OW, Rosenfeld LD. Alveolar crest reduction following full and partial thickness flaps. *J Periodontol*. 1972 Mar;43(3):141-4. PMID: 4501971 DOI: 10.1902/jop.1972.43.3.141.
3. Caton J, Zander HA. Osseous repair of an infrabony pocket without new attachment of connective tissue. *J Clin Periodontol*. 1976 Feb;3(1):54-8. PMID: 815276 DOI: 10.1111/j.1600-051x.1976.tb01850.x.
4. Caton J, Nyman S, Zander H. Histometric evaluation of periodontal surgery. II. Connective tissue attachment levels after four regenerative procedures. *J Clin Periodontol*. 1980 Jun;7(3):224-31. PMID: 7000854 DOI: 10.1111/j.1600-051x.1980.tb01965.x.
5. Caton J, Nyman S. Histometric evaluation of periodontal surgery. III. The effect of bone resection on the connective tissue attachment level. *J Periodontol*. 1981;52:405-409.
6. Listgarten MA, Rosenberg S, Lerner S. Progressive replacement of epithelial attachment by a connective tissue junction after experimental periodontal surgery in rats. *J Periodontol*. 1982 Nov;53(11):659-70. PMID: 6960165 DOI: 10.1902/jop.1982.53.11.659.
7. Lindhe J, Nyman S, Karring T. Connective tissue reattachment as related to presence or absence of alveolar bone. *J Clin Periodontol*. 1984 Jan;11(1):33-40. PMID: 6363460 DOI: 10.1111/j.1600-051x.1984.tb01306.x.
8. Karring T, Isidor F, Nyman S, Lindhe J. New attachment formation on teeth with a reduced but healthy periodontal ligament. *J Clin Periodontol*. 1985 Jan;12(1):51-60. PMID: 3855871 DOI: 10.1111/j.1600-051x.1985.tb01353.x.
9. Steiner SS, Crigger M, Egelberg J. Connective tissue regeneration to periodontally diseased teeth II. Histologic observations of cases following replaced flap surgery. *J Perio Res*. 1981;16:109-116.

16.3 Wound healing: periodontal regenerative surgery

Questions to be answered from this topic –

- Is there any difference in healing potential between cell types in periodontium?
 - What happens after the autogenous bone graft into the periodontal intrabony defects in histologic evaluation?
 - How does the wound heal after the autogenous bone graft was placed into the periodontal intrabony defects in histologic evaluation?
 - How does the wound heal after the allogeneic bone graft was placed into the periodontal intrabony defects in histologic evaluation?
 - How does the wound heal after the xenogeneic bone graft was placed into the periodontal intrabony defects in histologic evaluation?
 - How does the wound heal after a barrier membrane was placed in the periodontal intrabony defect in histologic evaluation?
 - How does the wound heal after enamel derivatives was placed into the periodontal intrabony defects in histologic evaluation?
 - How does the wound heal after platelet derived growth factor was placed into the periodontal intrabony defects in histologic evaluation?
 - How does the wound heal after a barrier membrane was placed in the supra-alveolar defect in histologic evaluation?
 - What is the effect of wound stability on the healing after a barrier membrane was placed in the supra-alveolar defect in histologic evaluation?
 - Does a type of barrier affect the wound healing after a barrier membrane was placed in the supra-alveolar defect in histologic evaluation?
1. Ellegaard B, et al. Composite jaw and iliac cancellous bone grafts in intrabony defects in monkeys. *J Periodontol Res*. 1976;11:299-310.

2. Melcher AH. On the repair potential of periodontal tissues. *J Periodontol*. 1976 May;47(5):256-60. PMID: 775048 DOI: 10.1902/jop.1976.47.5.256.
3. Nyman S, Karring T, Lindhe J, Plantén S. Healing following implantation of periodontitis-affected roots into gingival connective tissue. *J Clin Periodontol*. 1980 Oct;7(5):394-401. PMID: 6936413 DOI: 10.1111/j.1600-051x.1980.tb02012.x.
4. Karring T, Nyman S, Lindhe J. Healing following implantation of periodontitis affected roots into bone tissue. *J Clin Periodontol*. 1980 Apr;7(2):96-105. PMID: 6929795 DOI: 10.1111/j.1600-051x.1980.tb01952.x.
5. Cole RT, Crigger M, Bogle G, et al. Connective tissue regeneration to periodontally diseased teeth. A histological study. *J Periodontol Res*. 1980;15:1-9.
6. Nyman S, Gottlow J, Karring T, Lindhe J. The regenerative potential of the periodontal ligament. An experimental study in the monkey. *J Clin Periodontol*. 1982 May;9(3):257-65. PMID: 6954167 DOI: 10.1111/j.1600-051x.1982.tb02065.x.
7. Nyman S, Lindhe J, Karring T, Rylander H. New attachment following surgical treatment of human periodontal disease. *J Clin Periodontol*. 1982 Jul;9(4):290-6. PMID: 6964676 DOI: 10.1111/j.1600-051x.1982.tb02095.x.
8. Gottlow J, Nyman S, Karring T, Lindhe J. New attachment formation as the result of controlled tissue regeneration. *J Clin Periodontol*. 1984 Sep;11(8):494-503. PMID: 6384274 DOI: 10.1111/j.1600-051x.1984.tb00901.x.
9. Magnusson I, Nyman S, Karring T, Egelberg J. Connective tissue attachment formation following exclusion of gingival connective tissue and epithelium during healing. *J Periodontal Res*. 1985 Mar;20(2):201-8. PMID: 3159876 DOI: 10.1111/j.1600-0765.1985.tb00426.x.
10. Karring T, Isidor F, Nyman S, Lindhe J. New attachment formation on teeth with a reduced but healthy periodontal ligament. *J Clin Periodontol*. 1985 Jan;12(1):51-60. PMID: 3855871 DOI: 10.1111/j.1600-051x.1985.tb01353.x.
11. Gottlow J, Nyman S, Lindhe J, Karring T, Wennström J. New attachment formation in the human periodontium by guided tissue regeneration. Case reports. *J Clin Periodontol*. 1986 Jul;13(6):604-16. PMID: 3462208 DOI: 10.1111/j.1600-051x.1986.tb00854.x.
12. Gottlow J, Nyman S, Karring T. Maintenance of new attachment gained through guided tissue regeneration. *J Clin Periodontol*. 1992 May;19(5):315-7. PMID: 1517475 DOI: 10.1111/j.1600-051x.1992.tb00651.x.
13. Bowers GM, Chadroff B, Carnevale R, Mellonig J, Corio R, Emerson J, Stevens M, Romberg E. Histologic evaluation of new attachment apparatus formation in humans. Part I. *J Periodontol*. 1989 Dec;60(12):664-74. PMID: 2614631 DOI: 10.1902/jop.1989.60.12.664.
14. Bowers GM, Chadroff B, Carnevale R, Mellonig J, Corio R, Emerson J, Stevens M, Romberg E. Histologic evaluation of new attachment apparatus formation in humans. Part II. *J Periodontol*. 1989 Dec;60(12):675-82. PMID: 2614632 DOI: 10.1902/jop.1989.60.12.675.
15. Bowers GM, Chadroff B, Carnevale R, Mellonig J, Corio R, Emerson J, Stevens M, Romberg E. Histologic evaluation of new attachment apparatus formation in humans. Part III. *J Periodontol*. 1989 Dec;60(12):683-93. PMID: 2614633 DOI: 10.1902/jop.1989.60.12.683.
16. Wikesjö UM, Nilvénus R. Periodontal repair in dogs: effect of wound stabilization on healing. *J Periodontol*. 1990 Dec;61(12):719-24. PMID: 2269912 DOI: 10.1902/jop.1990.61.12.719.

17. Wikesjö UM, Nilvénus R. Periodontal repair in dogs. Healing patterns in large circumferential periodontal defects. *J Clin Periodontol.* 1991 Jan;18(1):49-59. PMID: 2045518 DOI: 10.1111/j.1600-051x.1991.tb01119.x.
18. Cortellini P, Pini Prato P, Tonetti MS. Periodontal regeneration: Re-entry and bone measurements. *J Periodontol.* 1993;64:261-268.
19. Wikesjö UM, Lim WH, Thomson RC, Hardwick WR. Periodontal repair in dogs: gingival tissue occlusion, a critical requirement for GTR? *J Clin Periodontol.* 2003 Jul;30(7):655-64. PMID: 12834504 DOI: 10.1034/j.1600-051x.2003.00362.x.
20. Nevins M, et al. Periodontal regeneration in humans using recombinant human platelet-derived growth factor-BB (rhPDGF-BB) and allogenic bone. *J Periodontol.* 2003;74(9):1282-1292.
21. Ridgway HK, Mellonig JT, Cochran DL. Human histologic and clinical evaluation of recombinant human platelet-derived growth factor and beta-tricalcium phosphate for the treatment of periodontal intraosseous defects. *Int J Periodontics & Rest Dentistry.* 2008;28(2):171-179.
22. Mellonig JT. Enamel matrix derivative for periodontal reconstructive surgery: technique and clinical histologic case report. *Int J Periodontics & Rest Dentistry.* 1999;19:9-20.

16.4 Wound healing: periodontal plastic surgery

Questions to be answered from this topic –

- How does the free gingival graft heal in overall histologic evaluation?
- How does the free gingival graft revascularize in histologic evaluation?
- Does a recipient site preparation affect the wound healing after the free gingival graft in histologic evaluation?
- Does a recipient site preparation affect the wound healing after the connective tissue graft in histologic evaluation?
- How does the wound heal after a barrier membrane was placed over the root surface to treat the gingival recession in histologic evaluation?
- How does the wound heal after a gingival graft was placed over the root surface to treat the gingival recession in histologic evaluation?
- How does the wound heal after a connective tissue graft was placed over the root surface to treat the gingival recession in histologic evaluation?
- How does the wound heal after platelet derived growth factor was placed over the root surface to treat the gingival recession in histologic evaluation?
- How does the wound heal after allogenic tissue graft was placed over the root surface to increase the soft tissue in histologic evaluation?
- How does the wound heal after xenogenic tissue graft was placed over the root surface to increase the soft tissue in histologic evaluation?

1. Sullivan HC, Atkins JH. Free autogenous gingival grafts. I. Principles of successful grafting. *Periodontics.* 1968 Jun;6(3):121-9. PMID: 5240496.
2. Oliver RC, Löe H, Karring T. Microscopic evaluation of the healing and revascularization of free gingival grafts. *J Periodontal Res.* 1968;3(2):84-95. PMID: 4249992 DOI: 10.1111/j.1600-0765.1968.tb01908.x.
3. Karring T, Cumming BR, Oliver RC, Löe H. The origin of granulation tissue and its impact on postoperative results of mucogingival surgery. *J Periodontol.* 1975 Oct;46(10):577-85. PMID: 810567 DOI: 10.1902/jop.1975.46.10.577.

4. James WC, McFall WT Jr, Burkes EJ. Placement of free gingival grafts on denuded alveolar bone. Part II: microscopic observations. *J Periodontol.* 1978 Jun;49(6):291-300. PMID: 279659 DOI: 10.1902/jop.1978.49.6.291.
5. Caffesse RG, Burgett FG, Nasjleti CE, Castelli WA. Healing of free gingival grafts with and without periosteum. Part I. Histologic evaluation. *J Periodontol.* 1979 Nov;50(11):586-94. PMID: 115984 DOI: 10.1902/jop.1979.50.11.586.
6. Cortellini P, Clauser C, Pini Prato GP. Histologic assessment of new attachment following the treatment of a human buccal recession by means of a guided tissue regeneration procedure. *J Periodontol.* 1993;64:387-391.
7. Pasquinelli KL. The histology of new attachment utilizing a thick autogenous soft tissue graft in an area of deep recession: a case report. *Int J Periodontics Restorative Dent.* 1995 Jun;15(3):248-57. PMID: 7558658.
8. Harris RJ. A comparative study of root coverage obtained with guided tissue regeneration utilizing a bioabsorbable membrane versus the connective tissue with partial-thickness double pedicle graft. *J Periodontol.* 1997 Aug;68(8):779-90. PMID: 9287070 DOI: 10.1902/jop.1997.68.8.779.
9. Harris RJ. Human histologic evaluation of root coverage obtained with a connective tissue with partial thickness double pedicle graft. A case report. *J Periodontol.* 1999 Jul;70(7):813-21. PMID: 10440645 DOI: 10.1902/jop.1999.70.7.813.
10. Harris RJ. Successful root coverage: a human histologic evaluation of a case. *Int J Periodontics Restorative Dent.* 1999 Oct;19(5):439-47. PMID: 10709509
11. Harris RJ. Histologic evaluation of root coverage obtained with GTR in humans: a case report. *Int J Periodontics Restorative Dent.* 2001 Jun;21(3):240-51. PMID: 11490401
12. Bruno JF, Bowers GM. Histology of a human biopsy section following the placement of a subepithelial connective tissue graft. *Int J Periodontics Restorative Dent.* 2000 Jun;20(3):225-31. PMID: 11203564.
13. Guiha R, el Khodeiry S, Mota L, Caffesse R. Histological evaluation of healing and revascularization of the subepithelial connective tissue graft. *J Periodontol.* 2001 Apr;72(4):470-8. PMID: 11338299 DOI: 10.1902/jop.2001.72.4.470.
14. Goldstein M, Boyan BD, Cochran DL, Schwartz Z. Human histology of new attachment after root coverage using subepithelial connective tissue graft. *J Clin Periodontol.* 2001 Jul;28(7):657-62. PMID: 11422587 DOI: 10.1034/j.1600-051x.2001.028007657.x.
15. Wei PC, Laurell L, Lingen MW, Geivelis M. Acellular dermal matrix allografts to achieve increased attached gingiva. Part 2. A histological comparative study. *J Periodontol.* 2002;73:257-265.
16. McGuire M, Cochran D. Evaluation of Human Recession Defects Treated with Coronally Advanced Flaps and Either Enamel Matrix Derivative or Connective Tissue. Part 2: Histological Evaluation. *J Periodontol.* 2003;74:1126-1135
17. Cummings LC, Kaldahl WB, Allen EP. Histologic evaluation of autogenous connective tissue and acellular dermal matrix grafts in humans. *J Periodontol.* 2005;76:178-186.
18. Nevins M, Nevins ML, Kim SW et al. The use of mucograft collagen matrix to augment the zone of keratinized tissue around teeth: a pilot study *Int J Periodontics Restorative Dent.* 2011;31:367-73.
19. Camelo M, Nevins M, Nevins ML et al. Treatment of gingival recession defects with xenogenic collagen matrix: a histologic report. *Int J Periodontics Restorative Dent.* 2012;32:167-73.

Questions to be answered from this topic:

- Why is supportive periodontal therapy necessary?
 - What is the importance of patient compliance in treating periodontal diseases?
 - What is the prevalence of tooth loss during maintenance?
 - What are the results of when patients are not maintained?
 - What is the ideal maintenance frequency after periodontal treatment?
 - How can one manage patients who do not respond well to periodontal therapy?
1. Axelsson P, Lindhe J. The significance of maintenance care in the treatment of periodontal disease. *J Clin Periodontol.* 1981 Aug;8(4):281-94. PMID: 6947992 DOI: 10.1111/j.1600-051x.1981.tb02039.x.
 2. Axelsson P, Lindhe J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. Results after 6 years. *J Clin Periodontol.* 1981 Jun;8(3):239-48. PMID: 6947990 DOI: 10.1111/j.1600-051x.1981.tb02035.x.
 3. Axelsson P, Nyström B, Lindhe J. The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *J Clin Periodontol.* 2004 Sep;31(9):749-57. PMID: 15312097 DOI: 10.1111/j.1600-051X.2004.00563.x.
 4. Ramfjord S, Morrison F, Burgett R., et al. Oral hygiene and maintenance of periodontal support. *J Periodontol.* 1982;53:26-30.
 5. Becker W, Becker BE, Berg LE. Periodontal treatment without maintenance. A retrospective study in 44 patients. *J Periodontol.* 1984 Sep;55(9):505-9. PMID: 6592322 DOI: 10.1902/jop.1984.55.9.505.
 6. Lindhe J, Nyman S. Long-term maintenance of patients treated for advanced periodontal disease. *J Clin Periodontol.* 1984 Sep;11(8):504-14. PMID: 6384275 DOI: 10.1111/j.1600-051x.1984.tb00902.x.
 7. Magnusson I, Lindhe J, Yoneyama T, Liljenberg B. Recolonization of a subgingival microbiota following scaling in deep pockets. *J Clin Periodontol.* 1984 Mar;11(3):193-207. PMID: 6368611 DOI: 10.1111/j.1600-051x.1984.tb01323.x.
 8. Listgarten MA, Sullivan P, George C et al. Comparative longitudinal study of 2 methods of scheduling maintenance visits: 4-year data. *J Clin Periodontol.* 1989;16:105-115.
 9. Wilson TG Jr, Glover ME, Schoen J, Baus C, Jacobs T. Compliance with maintenance therapy in a private periodontal practice. *J Periodontol.* 1984 Aug;55(8):468-73. PMID: 6384465 DOI: 10.1902/jop.1984.55.8.468.
 10. Wilson TG Jr, Hale S, Temple R. The results of efforts to improve compliance with supportive periodontal treatment in a private practice. *J Periodontol.* 1993 Apr;64(4):311-4. PMID: 8483095 DOI: 10.1902/jop.1993.64.4.311.
 11. Rosen B, Olavi G, Badersten A, et al. Effect of different frequencies of preventive maintenance treatment on periodontal conditions. 5-year observations in general dentistry patients. *J Clin Periodontol.* 1999;26:225-233.
 12. Novaes AB Jr, Novaes AB. Compliance with supportive periodontal therapy. Part 1. Risk of non-compliance in the first 5-year period. *J Periodontol.* 1999 Jun;70(6):679-82. PMID: 10397523 DOI: 10.1902/jop.1999.70.6.679.
 13. König J, Plagmann H-C, Langenfeld N, Kocher T. Retrospective comparison of clinical variables between compliant and non-compliant patients. *J Clin Periodontol.* 2001;28:227-232.
 14. Heasman PA, McCracken GI, Steen N. Supportive periodontal care: the effect of periodic subgingival debridement compared with supragingival prophylaxis with respect to clinical outcomes. *J Clin Periodontol.* 2002;29 Suppl 3:163-72; discussion 195-6. PMID: 12787216 DOI: 10.1034/j.1600-051x.29.s3.9.x.

15. Matuliene G, Pjetursson BE, Salvi GE, et al. Influence of residual pockets on progression of periodontitis and tooth loss: results after 11 years of maintenance. *J Clin Periodontol.* 2008;35:685-95.
16. Eickholz P, Kaltschmitt J, Berbig J, Reitmeir P, Pretzl B. Tooth loss after active periodontal therapy. I: patient-related factors for risk, prognosis, and quality of outcome. *J Clin Periodontol.* 2008;35:165-74.
17. Miyamoto T, Kumagai T, Jones JA, Van Dyke TE, Nunn ME. Compliance as a prognostic indicator: retrospective study of 505 patients treated and maintained for 15 years. *J Periodontol.* 2006 Feb;77(2):223-32. PMID: 16460248 DOI: 10.1902/jop.2006.040349.
18. Miyamoto T, Kumagai T, Lang MS, Nunn ME. Compliance as a prognostic indicator. II. Impact of patient's compliance to the individual tooth survival. *J Periodontol.* 2010 Sep;81(9):1280-8. PMID: 20397906 DOI: 10.1902/jop.2010.100039.
19. Feres M, Gursky LC, Faveri M, Tsuzuki CO, Figueiredo LC. Clinical and microbiological benefits of strict supragingival plaque control as part of the active phase of periodontal therapy. *J Clin Periodontol.* 2009 Oct;36(10):857-67. PMID: 19703236 DOI: 10.1111/j.1600-051X.2009.01471.x.
20. Ng MC, Ong MM, Lim LP, Koh CG, Chan YH. Tooth loss in compliant and non-compliant periodontally treated patients: 7 years after active periodontal therapy. *J Clin Periodontol.* 2011 May;38(5):499-508. PMID: 21342213 DOI: 10.1111/j.1600-051X.2011.01708.x.
21. Fardal Ø, Grytten J. A comparison of teeth and implants during maintenance therapy in terms of the number of disease-free years and costs – an in vivo internal control study. *J Clin Periodontol.* 2013;40:645–651.
22. Fardal Ø, Grytten J, Martin J, et al. Using prognostic factors from case series and cohort studies to identify individuals with poor long-term outcomes during periodontal maintenance. *J Clin Periodontol.* 2016;43:789–796.
23. Costa et al. Tooth loss in individuals under periodontal maintenance therapy: 5-year prospective study. *J Periodontal Res.* 2014;49:121-8.
24. Salvi GE. Time between recall visits and residual probing depths predict long-term stability in patients enrolled in supportive periodontal therapy. *J Clin Periodontol.* 2019;46:218-230. DOI: 10.1111/jcpe

Review:

Kerry G. J. (1996). Retreatment for patients with inflammatory periodontal disease. *Periodontology 2000*, 12, 125–126. <https://doi.org/10.1111/j.1600-0757.1996.tb00088.x>

18. Current Concepts of Other Dental Disciplines

18.1 Periodontal-Restorative Considerations

Tissue-restorative interactions: subgingival margin, marginal ridge relationships, open contacts

1. Newcomb GM. The relationship between the location of subgingival crown margins and gingival inflammation. *J Periodontol.* 1974 Mar;45(3):151-4. doi: 10.1902/jop.1974.45.3.151. PMID: 4522124.
2. Kepic TJ, O'Leary TJ. Role of marginal ridge relationships as an etiologic factor in periodontal disease. *J Periodontol.* 1978 Nov;49(11):570-5. doi: 10.1902/jop.1978.49.11.570. PMID: 281486.
3. Hancock EB, Mayo CV, Schwab RR, Wirthlin MR. Influence of interdental contacts on periodontal status. *J Periodontol.* 1980 Aug;51(8):445-9. doi: 10.1902/jop.1980.51.8.445. PMID: 6931204.

4. Jeffcoat MK, Howell TH. Alveolar bone destruction due to overhanging amalgam in periodontal disease. *J Periodontol.* 1980 Oct;51(10):599-602. doi: 10.1902/jop.1980.51.10.599. PMID: 6934287.
5. Rodriguez-Ferrer HJ, Strahan JD, Newman HN. Effect of gingival health of removing overhanging margins of interproximal subgingival amalgam restorations. *J Clin Periodontol.* 1980 Dec;7(6):457-62. doi: 10.1111/j.1600-051x.1980.tb02152.x. PMID: 6938526.
6. Lang NP, Kiel RA, Anderhalden K. Clinical and microbiological effects of subgingival restorations with overhanging or clinically perfect margins. *J Clin Periodontol.* 1983 Nov;10(6):563-78. doi: 10.1111/j.1600-051x.1983.tb01295.x. PMID: 6581173.
7. Stetler KJ, Bissada NF. Significance of the width of keratinized gingiva on the periodontal status of teeth with submarginal restorations. *J Periodontol.* 1987 Oct;58(10):696-700. doi: 10.1902/jop.1987.58.10.696. PMID: 2444693.
8. Flores-de-Jacoby L, Zafiropoulos GG, Ciancio S. Effect of crown margin location on plaque and periodontal health. *Int J Periodontics Restorative Dent.* 1989;9(3):197-205. PMID: 2700985.
9. Wang HL, Burgett FG, Shyr Y. The relationship between restoration and furcation involvement on molar teeth. *J Periodontol.* 1993 Apr;64(4):302-5. doi: 10.1902/jop.1993.64.4.302. PMID: 8483093.
10. Schätzle M, Land NP, Anerud A, Boysen H, Bürgin W, Löe H. The influence of margins of restorations of the periodontal tissues over 26 years. *J Clin Periodontol.* 2001 Jan;28(1):57-64. doi: 10.1034/j.1600-051x.2001.280109.x. PMID: 11142668.

Prosthetic rehabilitation in periodontitis patients

1. Nyman S, Lindhe J. Prosthetic rehabilitation of patients with advanced periodontal disease. *J Clin Periodontol.* 1976 Aug;3(3):135-47. PMID: 1067275 DOI: 10.1111/j.1600-051x.1976.tb01861.x.
2. Nyman S, Lindhe J. A longitudinal study of combined periodontal and prosthetic treatment of patients with advanced periodontal disease. *J Periodontol.* 1979 Apr;50(4):163-9. PMID: 374703 DOI: 10.1902/jop.1979.50.4.163.
3. Bergman B, Hugoson A, Olsson CO. Caries, periodontal and prosthetic findings in patients with removable partial dentures: a ten-year longitudinal study. *J Prosthet Dent.* 1982 Nov;48(5):506-14. PMID: 6754910 DOI: 10.1016/0022-3913(82)90352-3.
4. Valderhaug J, Ellingsen JE, Jokstad A. Oral hygiene, periodontal conditions and carious lesions in patients treated with dental bridges. A 15-year clinical and radiographic follow-up study. *J Clin Periodontol.* 1993 Aug;20(7):482-9. PMID: 8354722 DOI: 10.1111/j.1600-051x.1993.tb00395.x.
5. Zlatarić DK, Celebić A, Valentić-Peruzović M. The effect of removable partial dentures on periodontal health of abutment and non-abutment teeth. *J Periodontol.* 2002 Feb;73(2):137-44. PMID: 11895277 DOI: 10.1902/jop.2002.73.2.137.
6. Lulic M, Brägger U, Lang NP, Zwahlen M, Salvi GE. Ante's (1926) law revisited: a systematic review on survival rates and complications of fixed dental prostheses (FDPs) on severely reduced periodontal tissue support. *Clin Oral Implants Res.* 2007 Jun;18 Suppl 3:63-72. PMID: 17594371 DOI: 10.1111/j.1600-0501.2007.01438.x.
7. Fardal O, Linden GJ. Long-term outcomes for cross-arch stabilizing bridges in periodontal maintenance patients--a retrospective study. *J Clin Periodontol.* 2010 Mar;37(3):299-304. PMID: 20070860 DOI: 10.1111/j.1600-051X.2009.01528.x.

8. Brägger U, Hirt-Steiner S, Schnell N, Schmidlin K, Salvi GE, Pjetursson B, Matuliene G, Zwahlen M, Lang NP. Complication and failure rates of fixed dental prostheses in patients treated for periodontal disease. *Clin Oral Implants Res.* 2011 Jan;22(1):70-7. PMID: 21158932 DOI: 10.1111/j.1600-0501.2010.02095.x.
9. Graetz C, Schwendicke F, Kahl M, Dörfer CE, Sälzer S, Springer C, Schützhold S, Kocher T, König J, Rühling A. Prosthetic rehabilitation of patients with history of moderate to severe periodontitis: a long-term evaluation. *J Clin Periodontol.* 2013 Aug;40(8):799-806. PMID: 23758333 DOI: 10.1111/jcpe.12124.

Posterior bite collapse

Nakamura SS, Donatelli D, Rosenberg ES. Posterior Bite Collapse and Diagnostic Grading for Periodontitis. *Int J Periodontics Restorative Dent.* 2021 Jan-Feb;41(1):61-69. doi: 10.11607/prd.4930. PMID: 33528452.

Reviews:

1. Lang NP. Periodontal considerations in prosthetic dentistry. *Periodontol 2000.* 1995 Oct;9:118-31. doi: 10.1111/j.1600-0757.1995.tb00060.x. PMID: 9567982.
2. Lulic M, Brägger U, Lang NP, Zwahlen M, Salvi GE. Ante's (1926) law revisited: a systematic review on survival rates and complications of fixed dental prostheses (FDPs) on severely reduced periodontal tissue support. *Clin Oral Implants Res.* 2007 Jun;18 Suppl 3:63-72. doi: 10.1111/j.1600-0501.2007.01438.x. Erratum in: *Clin Oral Implants Res.* 2008 Mar;19(3):326-8. PMID: 17594371.
3. Abduo J, Lyons KM. Interdisciplinary interface between fixed prosthodontics and periodontics. *Periodontol 2000.* 2017 Jun;74(1):40-62. doi: 10.1111/prd.12189. PMID: 28429481.
4. Bennani V, Ibrahim H, Al-Harthi L, Lyons KM. The periodontal restorative interface: esthetic considerations. *Periodontol 2000.* 2017 Jun;74(1):74-101. doi: 10.1111/prd.12191. PMID: 28429482.
5. Ercoli C, Caton JG. Dental prostheses and tooth-related factors. *J Clin Periodontol.* 2018 Jun;45 Suppl 20:S207-S218. doi: 10.1111/jcpe.12950. PMID: 29926482.
6. Tomasi C, Albouy JP, Schaller D, Navarro RC, Derkx J. Efficacy of rehabilitation of stage IV periodontitis patients with full-arch fixed prostheses: Tooth-supported versus Implant-supported-A systematic review. *J Clin Periodontol.* 2022 Jun;49 Suppl 24:248-271. doi: 10.1111/jcpe.13511. Epub 2021 Nov 10. PMID: 34761430.
7. Montero E, Molina A, Palombo D, Morón B, Pradés G, Sanz-Sánchez I. Efficacy and risks of tooth-supported prostheses in the treatment of partially edentulous patients with stage IV periodontitis. A systematic review and meta-analysis. *J Clin Periodontol.* 2022 Jun;49 Suppl 24:182-207. doi: 10.1111/jcpe.13482. Epub 2021 Nov 16. PMID: 34786742.
8. Gotfredsen K, Rimborg S, Stavropoulos A. Efficacy and risks of removable partial prosthesis in periodontitis patients: A systematic review. *J Clin Periodontol.* 2022 Jun;49 Suppl 24:167-181. doi: 10.1111/jcpe.13519. Epub 2021 Nov 10. PMID: 34761421.
9. Donos N, André Mezzomo L, Mardas N, Goldoni M, Calciolari E. Efficacy of tooth-supported compared to implant-supported full-arch removable prostheses in patients with terminal dentition. A systematic review. *J Clin Periodontol.* 2022 Jun;49 Suppl 24:224-247. doi: 10.1111/jcpe.13477. Epub 2021 Nov 14. PMID: 34775624.

18.2 Periodontal-Endodontic Considerations

Classification

Herrera D, Retamal-Valdes B, Alonso B, Feres M. Acute periodontal lesions (periodontal abscesses and necrotizing periodontal diseases) and endo-periodontal lesions. *J Clin Periodontol.* 2018 Jun;45 Suppl 20:S78-S94. doi: 10.1111/jcpe.12941. PMID: 29926493.

Periodontal abscesses

1. Newman MG, Sims TN. The predominant cultivable microbiota of the periodontal abscess. *J Periodontol.* 1979 Jul;50(7):350-4. doi: 10.1902/jop.1979.50.7.350. PMID: 38308.
2. DeWitt GV, Cobb CM, Killoy WJ. The acute periodontal abscess: microbial penetration of the soft tissue wall. *Int J Periodontics Restorative Dent.* 1985;5(1):38-51. PMID: 3888899.
3. Dello Russo NM. The post-prophylaxis periodontal abscess: etiology and treatment. *Int J Periodontics Restorative Dent.* 1985;5(1):28-37. PMID: 3888898.
4. McLeod DE, Lainson PA, Spivey JD. Tooth loss due to periodontal abscess: a retrospective study. *J Periodontol.* 1997 Oct;68(10):963-6. doi: 10.1902/jop.1997.68.10.963. PMID: 9358362.
5. Herrera D, Roldán S, González I, Sanz M. The periodontal abscess (I). Clinical and microbiological findings. *J Clin Periodontol.* 2000 Jun;27(6):387-94. doi: 10.1034/j.1600-051x.2000.027006387.x. PMID: 10883867.
6. Herrera D, Roldán S, O'Connor A, Sanz M. The periodontal abscess (II). Short-term clinical and microbiological efficacy of 2 systemic antibiotic regimes. *J Clin Periodontol.* 2000 Jun;27(6):395-404. doi: 10.1034/j.1600-051x.2000.027006395.x. PMID: 10883868.
7. Jaramillo A, Arce RM, Herrera D, Betancourth M, Botero JE, Contreras A. Clinical and microbiological characterization of periodontal abscesses. *J Clin Periodontol.* 2005 Dec;32(12):1213-8. doi: 10.1111/j.1600-051X.2005.00839.x. PMID: 16268997.

Perio-endo lesions

1. Mazur B, Massler M. Influence of periodontal disease on the dental pulp. *Oral Surg Oral Med Oral Pathol.* 1964 May;17:592-603. PMID: 14131578 DOI: 10.1016/0030-4220(64)90363-9.
2. Simon JH, Glick DH, Frank AL. The relationship of endodontic-periodontic lesions. *J Periodontol.* 1972 Apr;43(4):202-8. PMID: 4505605 DOI: 10.1902/jop.1972.43.4.202.
3. Langeland K, Rodrigues H, Dowden W. Periodontal disease, bacteria, and pulpal histopathology. *Oral Surg Oral Med Oral Pathol.* 1974 Feb;37(2):257-70. PMID: 4520855 DOI: 10.1016/0030-4220(74)90421-6.
4. Kirkham D. The location and incidence of accessory canals in periodontal pockets. *J Amer Dent Assoc.* 1975;91:353-356. DOI: 10.14219/jada.archive.1975.0345.
5. Gutmann JL. Prevalence, location, and patency of accessory canals in the furcation region of permanent molars. *J Periodontol.* 1978 Jan;49(1):21-6. PMID: 271710 DOI: 10.1902/jop.1978.49.1.21.
6. Gher ME Jr, Dunlap RM, Anderson MH, Kuhl LV. Clinical survey of fractured teeth. *J Am Dent Assoc.* 1987 Feb;114(2):174-7. PMID: 3102764 DOI: 10.14219/jada.archive.1987.0006.

7. Ehnevid H, Jansson L, Lindsjög S, Blomlöf L. Periodontal healing in teeth with periapical lesions. A clinical retrospective study. *J Clin Periodontol.* 1993 Apr;20(4):254-8. PMID: 8473535 DOI: 10.1111/j.1600-051x.1993.tb00354.x.
8. Jansson L, Ehnevid H, Lindsjög S, Blomlöf L. The influence of endodontic infection on progression of marginal bone loss in periodontitis. *J Clin Periodontol.* 1995;22:729-734.
9. Jansson LE, Ehnevid H. The influence of endodontic infection on periodontal status in mandibular molars. *J Periodontol.* 1998 Dec;69(12):1392-6. PMID: 9926769 DOI: 10.1902/jop.1998.69.12.1392.

Influence of endodontic treatment on periodontium

1. Cortellini P, Tonetti MS. Evaluation of the effect of tooth vitality on regenerative outcomes in infrabony defects. *J Clin Periodontol.* 2001 Jul;28(7):672-9.
2. Katsamakis S, Timmerman MF, Van der Velden U, de Cleen MJH, Van der Weijden F. Patterns of bone loss around teeth restored with endodontic posts. *J Clin Periodontol.* 2009;36:940–949. doi: 10.1111/j.1600-051X.2009.01465.x.
3. de Sanctis M, Goracci C, Zucchelli G. Long-term effect on tooth vitality of regenerative therapy in deep periodontal bony defects: a retrospective study. *Int J Periodontics Restorative Dent.* 2013 Mar-Apr;33(2):151-7. PMID: 23484170 DOI: 10.11607/prd.1461.
4. de Miranda JL, Santana CM, Santana RB. Influence of endodontic treatment in the post-surgical healing of human Class II furcation defects. *J Periodontol.* 2013 Jan;84(1):51-7. PMID: 22769438 DOI: 10.1902/jop.2012.110363.
5. Bertl K, Suljkanovic N, Suljkanovic L, Lettner S, Esfandeyari A, Moritz A, Stavropoulos A, Bruckmann C. A root canal filling per se does not have a significant negative effect on the marginal periodontium. *J Clin Periodontol.* 2015 Jun;42(6):520-9. PMID: 25926391 DOI: 10.1111/jcpe.12408.

Treatment of perio-endo lesions

Schmidt JC, Walter C, Amato M, Weiger R. Treatment of periodontal-endodontic lesions--a systematic review. *J Clin Periodontol.* 2014 Aug;41(8):779-90. doi: 10.1111/jcpe.12265. Epub 2014 Jul 2. PMID: 24766568.

Influence of endodontic infection on marginal periodontium

Jansson L, Ehnevid H, Lindsjög S, Blomlöf L. The influence of endodontic infection on progression of marginal bone loss in periodontitis. *J Clin Periodontol.* 1995;22(10):729-734. doi:10.1111/j.1600-051x.1995.tb00254.x

Influence of periodontal disease on the dental pulp

Mazur B, Massler M. Influence of Perioodntal Disease of the Dental Pulp. *Oral Surg Oral Med Oral Pathol.* 1964;17:592-603. doi:10.1016/0030-4220(64)90363-9

Review:

1. Chen SY, Wang HL, Glickman GN. The influence of endodontic treatment upon periodontal wound healing. *J Clin Periodontol.* 1997 Jul;24(7):449-56. doi: 10.1111/j.1600-051x.1997.tb00211.x. PMID: 9226384. ⁹⁶

2. Zehnder M, Gold SI, Hasselgren G. Pathologic interactions in pulpal and periodontal tissues. *J Clin Periodontol*. 2002 Aug;29(8):663-71. doi: 10.1034/j.1600-051x.2002.290801.x. PMID: 12390561.
3. Herrera D, Alonso B, de Arriba L, Santa Cruz I, Serrano C, Sanz M. Acute periodontal lesions. *Periodontol 2000*. 2014 Jun;65(1):149-77. doi: 10.1111/prd.12022. PMID: 24738591.
4. Slots J. Focal infection of periodontal origin. *Periodontol 2000*. 2019 Feb;79(1):233-235. doi: 10.1111/prd.12258. PMID: 30892771.
5. Dahlén G. Microbiology and treatment of dental abscesses and periodontal-endodontic lesions. *Periodontol 2000*. 2002;28:206-39. doi: 10.1034/j.1600-0757.2002.280109.x. PMID: 12013343.
6. Rotstein I, Simon JH. Diagnosis, prognosis and decision-making in the treatment of combined periodontal-endodontic lesions. *Periodontol 2000*. 2004;34:165-203. doi: 10.1046/j.0906-6713.2003.003431.x. PMID: 14717862.
7. Rotstein I. Interaction between endodontics and periodontics. *Periodontol 2000*. 2017 Jun;74(1):11-39. doi: 10.1111/prd.12188. PMID: 28429484.

18.3 Periodontal-Orthodontic Considerations

Pathologic tooth migration

Martinez-Canut P, Carrasquer A, Magán R, Lorca A. A study on factors associated with pathologic tooth migration. *J Clin Periodontol*. 1997 Jul;24(7):492-7. doi: 10.1111/j.1600-051x.1997.tb00217.x. PMID: 9226390.

Histologic/histochemical effects of tooth movement

Reitan K. Clinical and histologic observations on tooth movement during and after orthodontic treatment. *Am J Orthod*. 1967 Oct;53(10):721-45. doi: 10.1016/0002-9416(67)90118-2. PMID: 5233926.

Effect of orthodontic movement on periodontium

1. Wainwright WM. Faciolingual tooth movement: its influence on the root and cortical plate. *Am J Orthod*. 1973 Sep;64(3):278-302. doi: 10.1016/0002-9416(73)90021-3. PMID: 4199008.
2. Wingard CE, Bowers GM. The effects of facial bone from facial tipping of incisors in monkeys. *J Periodontol*. 1976 Aug;47(8):450-4. doi: 10.1902/jop.1976.47.8.450. PMID: 820849.
3. Trossello VK, Gianelly AA. Orthodontic treatment and periodontal status. *J Periodontol*. 1979 Dec;50(12):665-71. doi: 10.1902/jop.1979.50.12.665. PMID: 294480.
4. Coatoam GW, Behrents RG, Bissada NF. The width of keratinized gingiva during orthodontic treatment: its significance and impact on periodontal status. *J Periodontol*. 1981 Jun;52(6):307-13. doi: 10.1902/jop.1981.52.6.307. PMID: 6167704.
5. Karring T, Nyman S, Thilander B, Magnusson I. Bone regeneration in orthodontically produced alveolar bone dehiscences. *J Periodontal Res*. 1982 May;17(3):309-15. doi: 10.1111/j.1600-0765.1982.tb01158.x. PMID: 6213761.

6. Polson AM, Reed BE. Long-term effect of orthodontic treatment on crestal alveolar bone levels. *J Periodontol.* 1984 Jan;55(1):28-34. doi: 10.1902/jop.1984.55.1.28. PMID: 6582262.
7. Polson A, Caton J, Polson AP, Nyman S, Novak J, Reed B. Periodontal response after tooth movement into intrabony defects. *J Periodontol.* 1984 Apr;55(4):197-202. doi: 10.1902/jop.1984.55.4.197. PMID: 6585537.
8. Diamanti-Kipioti A, Gusberti FA, Lang NP. Clinical and microbiological effects of fixed orthodontic appliances. *J Clin Periodontol.* 1987 Jul;14(6):326-33. doi: 10.1111/j.1600-051x.1987.tb00979.x. Erratum in: *J Clin Periodontol* 1990 Jan;17(1):66. PMID: 3509967.
9. Andlin-Sobocki A, Bodin L. Dimensional alterations of the gingiva related to changes of facial/lingual tooth position in permanent anterior teeth of children. A 2-year longitudinal study. *J Clin Periodontol.* 1993 Mar;20(3):219-24. doi: 10.1111/j.1600-051x.1993.tb00347.x. PMID: 8450088.
10. Wennström JL, Stokland BL, Nyman S, Thilander B. Periodontal tissue response to orthodontic movement of teeth with infrabony pockets. *Am J Orthod Dentofacial Orthop.* 1993 Apr;103(4):313-9. doi: 10.1016/0889-5406(93)70011-C. PMID: 8480696.
11. Araújo MG, Carmagnola D, Berglundh T, Thilander B, Lindhe J. Orthodontic movement in bone defects augmented with Bio-Oss. An experimental study in dogs. *J Clin Periodontol.* 2001 Jan;28(1):73-80. doi: 10.1034/j.1600-051x.2001.280111.x. PMID: 11142670.
12. Crescini A, Nieri M, Buti J, Baccetti T, Mauro S, Prato GP. Short- and long-term periodontal evaluation of impacted canines treated with a closed surgical-orthodontic approach. *J Clin Periodontol.* 2007 Mar;34(3):232-42. doi: 10.1111/j.1600-051X.2006.01042.x. Epub 2007 Jan 25. PMID: 17257160.
13. Ghezzi C, Masiero S, Silvestri M, Zanotti G, Rasperini G. Orthodontic treatment of periodontally involved teeth after tissue regeneration. *Int J Periodontics Restorative Dent.* 2008 Dec;28(6):559-67. PMID: 19146051.
14. Nart J, Carrió N, Valles C, Solís-Moreno C, Nart M, Reñé R, Esquinas C, Puigdollers A. Prevalence of altered passive eruption in orthodontically treated and untreated patients. *J Periodontol.* 2014 Nov;85(11):e348-53. doi: 10.1902/jop.2014.140264. Epub 2014 Aug 15. PMID: 25126692.
15. Zasčiurinskienė E, Basevičienė N, Lindsten R, Slotte C, Jansson H, Bjerklin K. Orthodontic treatment simultaneous to or after periodontal cause-related treatment in periodontitis susceptible patients. Part I: Clinical outcome. A randomized clinical trial. *J Clin Periodontol.* 2018 Feb;45(2):213-224. doi: 10.1111/jcpe.12835. Epub 2017 Dec 11. PMID: 29106749.

Molar Uprighting

1. Brown IS. The effect of orthodontic therapy on certain types of periodontal defects. I. Clinical findings. *J Periodontol.* 1973 Dec;44(12):742-56. doi: 10.1902/jop.1973.44.12.742. PMID: 4586682.
2. Ericsson I, Thilander B, Lindhe J, Okamoto H. The effect of orthodontic tilting movements on the periodontal tissues of infected and non-infected dentitions in dogs. *J Clin Periodontol.* 1977 Nov;4(4):278-93. doi: 10.1111/j.1600-051x.1977.tb01900.x. PMID: 271655.
3. Burch JG, Bagci B, Sabulski D, Landrum C. Periodontal changes in furcations resulting from orthodontic uprighting of mandibular molars. *Quintessence Int.* 1992 Jul;23(7):509-13. PMID: 1410254.

Intrusion

1. Corrente G, Abundo R, Re S, Cardaropoli D, Cardaropoli G. Orthodontic movement into infrabony defects in patients with advanced periodontal disease: a clinical and radiological study. *J Periodontol*. 2003 Aug;74(8):1104-9. doi: 10.1902/jop.2003.74.8.1104. PMID: 14514223.
2. Bellamy LJ, Kokich VG, Weissman JA. Using orthodontic intrusion of abraded incisors to facilitate restoration: the technique's effects on alveolar bone level and root length. *J Am Dent Assoc*. 2008 Jun;139(6):725-33. doi: 10.14219/jada.archive.2008.0254. PMID: 18519996.

Orthodontics and root resorption

Lupi JE, Handelman CS, Sadowsky C. Prevalence and severity of apical root resorption and alveolar bone loss in orthodontically treated adults. *Am J Orthod Dentofacial Orthop*. 1996 Jan;109(1):28-37. doi: 10.1016/s0889-5406(96)70160-9. PMID: 8540480.

Forced eruption of teeth

1. Ingber JS. Forced eruption. I. A method of treating isolated one and two wall infrabony osseous defects- rationale and case report. *J Periodontol*. 1974 Apr;45(4):199-206. doi: 10.1902/jop.1974.45.4.199. PMID: 4522455.
2. Batenhorst KF, Bowers GM, Williams JE Jr. Tissue changes resulting from facial tipping and extrusion of incisors in monkeys. *J Periodontol*. 1974 Sep;45(9):660-8. doi: 10.1902/jop.1974.45.9.660. PMID: 4529575.
3. Ingber JS. Forced eruption: part II. A method of treating nonrestorable teeth--Periodontal and restorative considerations. *J Periodontol*. 1976 Apr;47(4):203-16. doi: 10.1902/jop.1976.47.4.203. PMID: 1063857.
4. Ingber JS. Forced eruption: alteration of soft tissue cosmetic deformities. *Int J Periodontics Restorative Dent*. 1989;9(6):416-25. PMID: 2640214.
5. Salama H, Salama M. The role of orthodontic extrusive remodeling in the enhancement of soft and hard tissue profiles prior to implant placement: a systematic approach to the management of extraction site defects. *Int J Periodontics Restorative Dent*. 1993 Aug;13(4):312-33. PMID: 8300319.
6. Carvalho CV, Bauer FP, Romito GA, Pannuti CM, De Micheli G. Orthodontic extrusion with or without circumferential supracrestal fiberotomy and root planing. *Int J Periodontics Restorative Dent*. 2006 Feb;26(1):87-93. PMID: 16515100.
7. Amato F, Mirabella AD, Macca U, Tarnow DP. Implant site development by orthodontic forced extraction: a preliminary study. *Int J Oral Maxillofac Implants*. 2012 Mar-Apr;27(2):411-20. PMID: 22442782.
8. Hochman MN, Chu SJ, Tarnow DP. Orthodontic extrusion for implant site development revisited: a new classification determined by anatomy and clinical outcomes. *Semin Orthod*. 2014;20(3):208-227.
9. Kang PY, Habib R. Possible Complications With Implant Site Development Utilizing Orthodontic Extrusion: Three Case Reports. *Compend Contin Educ Dent*. 2019 May;40(5):292-297. PMID: 31067071.

Exposure of impacted teeth

10. Pini Prato G, Baccetti T, Magnani C, Agudio G, Cortellini P. Mucogingival interceptive surgery of buccally-erupted premolars in patients scheduled for orthodontic treatment. I. A 7-year longitudinal study. *J Periodontol*. 2000 Feb;71(2):172-81. doi: 10.1902/jop.2000.71.2.172. PMID: 10711607.

11. Pini Prato G, Baccetti T, Giorgetti R, Agudio G, Cortellini P. Mucogingival interceptive surgery of buccally-erupted premolars in patients scheduled for orthodontic treatment. II. Surgically treated versus nonsurgically treated cases. *J Periodontol.* 2000 Feb;71(2):182-7. doi: 10.1902/jop.2000.71.2.182. PMID: 10711608.
12. Kokich VG. Surgical and orthodontic management of impacted maxillary canines. *Am J Orthod Dentofacial Orthop.* 2004 Sep;126(3):278-83. doi: 10.1016/j.ajodo.2004.06.009. PMID: 15356485.

Periodontally accelerated osteogenic orthodontics (PAOO)

13. Murphy KG, Wilcko MT, Wilcko WM, Ferguson DJ. Periodontal accelerated osteogenic orthodontics: a description of the surgical technique. *J Oral Maxillofac Surg.* 2009 Oct;67(10):2160-6. doi: 10.1016/j.joms.2009.04.124. PMID: 19761909.
14. Wilcko MT, Ferguson DJ, Makki L, Wilcko WM. Keratinized Gingiva Height Increases After Alveolar Corticotomy and Augmentation Bone Grafting. *J Periodontol.* 2015 Oct;86(10):1107-15. doi: 10.1902/jop.2015.150074. Epub 2015 Jul 3. PMID: 26138808.

Review Papers

15. Vanarsdall RL. Orthodontics and periodontal therapy. *Periodontol 2000.* 1995 Oct;9:132-49. doi: 10.1111/j.1600-0757.1995.tb00061.x. PMID: 9567983.
16. Wennström JL. Mucogingival considerations in orthodontic treatment. *Semin Orthod.* 1996 Mar;2(1):46-54. doi: 10.1016/s1073-8746(96)80039-9. PMID: 9161283.
17. Keim RG. Aesthetics in clinical orthodontic-periodontic interactions. *Periodontol 2000.* 2001;27:59-71. doi: 10.1034/j.1600-0757.2001.027001059.x. PMID: 11551300.
18. Brunsvold MA. Pathologic tooth migration. *J Periodontol.* 2005 Jun;76(6):859-66. doi: 10.1902/jop.2005.76.6.859. PMID: 15948679.
19. Antoun JS, Mei L, Gibbs K, Farella M. Effect of orthodontic treatment on the periodontal tissues. *Periodontol 2000.* 2017 Jun;74(1):140-157. doi: 10.1111/prd.12194. PMID: 28429487.
20. Parkin N, Benson PE, Thind B, Shah A, Khalil I, Ghafoor S. Open versus closed surgical exposure of canine teeth that are displaced in the roof of the mouth. *Cochrane Database Syst Rev.* 2017 Aug 21;8(8):CD006966. doi: 10.1002/14651858.CD006966.pub3. PMID: 28828758; PMCID: PMC6483459.
21. Papageorgiou SN, Papadelli AA, Eliades T. Effect of orthodontic treatment on periodontal clinical attachment: a systematic review and meta-analysis. *Eur J Orthod.* 2018 Apr 6;40(2):176-194. doi: 10.1093/ejo/cjx052. PMID: 29106513.
22. Kao RT, Curtis DA, Kim DM, Lin GH, Wang CW, Cobb CM, Hsu YT, Kan J, Velasquez D, Avila-Ortiz G, Yu SH, Mandelaris GA, Rosen PS, Evans M, Gunsolley J, Goss K, Ambruster J, Wang HL. American Academy of Periodontology best evidence consensus statement on modifying periodontal phenotype in preparation for orthodontic and restorative treatment. *J Periodontol.* 2020 Mar;91(3):289-298. doi: 10.1002/JPER.19-0577. Epub 2020 Jan 13. PMID: 31943219.
23. Martin C, Celis B, Ambrosio N, Bollain J, Antonoglou GN, Figuero E. Effect of orthodontic therapy in periodontitis and non-periodontitis patients: a systematic review with meta-analysis. *J Clin Periodontol.* 2022 Jun;49 Suppl 24:72-101. doi: 10.1111/jcpe.13487. Epub 2021 Nov 22. PMID: 33998045.
24. Papageorgiou SN, Antonoglou GN, Michelogiannakis D, Kakali L, Eliades T, Madianos P. Effect of periodontal-orthodontic treatment of teeth with pathological tooth flaring, drifting, and elongation in patients with severe periodontitis: A systematic review with meta-analysis. *J Clin Periodontol.* 2022 Jun;49 Suppl

24(Suppl 24):102-120. doi: 10.1111/jcpe.13529. Epub 2021 Aug 18. PMID: 34327710; PMCID: PMC9290963.

25. Kloukos D, Rocuzzo A, Stähli A, Sculean A, Katsaros C, Salvi GE. Effect of combined periodontal and orthodontic treatment of tilted molars and of teeth with intra-bony and furcation defects in stage-IV periodontitis patients: A systematic review. *J Clin Periodontol*. 2022 Jun;49 Suppl 24:121-148. doi: 10.1111/jcpe.13509. Epub 2021 Nov 10. PMID: 34761413.

19. Principles of Implant Therapy: Examination, Diagnosis, and Treatment Planning

19. 1 Implant Tissue Interface & Wound Healing

Questions to be answered from this session:

- What is the peri-implant anatomy?
- Is the tissue interface around implant different than around teeth?
- What is the effect of implant position on tissue/bone level?
- What is osseointegration?
- How do dental implants heal with surrounding tissues?

1. Linder L, Albrektsson T, Branemark PI, et al. Electron microscopic analysis of the bone-titanium interface. *Acta Orthop Scand* 1983;54:45-52. PMID: 6829281 DOI: [10.3109/17453678308992868](https://doi.org/10.3109/17453678308992868)
2. Buser D, Warrer K, Karring T, Stich H. Titanium implants with a true periodontal ligament: an alternative to osseointegrated implants? *Int J Oral Maxillofac Implants* 1990;5:113-116. PMID: 2133335
3. Gottlander M, Albrektsson T. Histomorphometric studies of hydroxylapatite-coated and uncoated CP titanium threaded implants in bone. *Int J Oral Maxillofac Implants* 1991;6:399-404. PMID: 1820308
4. Listgarten MA, Buser D, Steinemann SG, Donath K, Lang NP, Weber HP. Light and transmission electron microscopy of the intact interfaces between non-submerged titanium-coated epoxy resin implants and bone or gingiva. *J Dent Res* 1992;71:364-371. PMID: 1556294 DOI: [10.1177/00220345920710020401](https://doi.org/10.1177/00220345920710020401)
5. Steflik DE, Parr GR, Sisk AL, et al. Osteoblast activity at the dental implant-bone interface: transmission electron microscopic and high voltage electron microscopic observations. *J Periodontol* 1994;65:404-413. PMID: 8046555 DOI: [10.1902/jop.1994.65.5.404](https://doi.org/10.1902/jop.1994.65.5.404)
6. Cochran DL, Hermann JS, Schenk RK, Higginbottom FL, Buser D. Biologic width around titanium implants. A histometric analysis of the implanto-gingival junction around unloaded and loaded nonsubmerged implants in the canine mandible. *J Periodontol* 1997;68:186-198. PMID: 9058338 DOI: [10.1902/jop.1997.68.2.186](https://doi.org/10.1902/jop.1997.68.2.186)
7. Hermann JS, Buser D, Schenk RK, Cochran DL. Crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged and submerged implants in the canine mandible. *J Periodontol* 2000;71:1412-1424. PMID: 11022770 DOI: [10.1902/jop.2000.71.9.1412](https://doi.org/10.1902/jop.2000.71.9.1412)
8. Tarnow DP, Cho SC, Wallace SS. The effect of inter-implant distance on the height of inter- implant bone crest. *J Periodontol* 2000;71:546-549. PMID: 10807116 DOI: [10.1902/jop.2000.71.4.546](https://doi.org/10.1902/jop.2000.71.4.546)
9. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. *J Periodontol* 1992;63:995- 6. DOI: [10.1902/jop.1992.63.12.995](https://doi.org/10.1902/jop.1992.63.12.995) PMID: 1474471
10. Cho HS, Jang HS, Kim DK, et al. The effects of interproximal distance between roots on the existence of interdental papillae according to the distance from the contact point to the alveolar crest. *J Periodontol* 2006;77:1651-7. DOI: [10.1902/jop.2006.060023](https://doi.org/10.1902/jop.2006.060023) PMID: 17032106

- 11.Choquet V, Hermans M, Adriaenssens P, Daelemans P, Tarnow DP, Malevez C. Clinical and radiographic evaluation of the papilla level adjacent to single-tooth dental implants. A retrospective study in the maxillary anterior region. *J Periodontol* 2001;72:1364-1371. PMID: 11699478 DOI: [10.1902/jop.2001.72.10.1364](https://doi.org/10.1902/jop.2001.72.10.1364)

Reviews:

- 12.Listgarten MA, Lang NP, Schroeder HE, Schroeder A. Periodontal tissues and their counterparts around endosseous implants [corrected and republished with original paging, article originally printed in *Clin Oral Implants Res* 1991 Jan-Mar;2(1):1-19]. *Clin Oral Implants Res* 1991;2(3):1- 19. PMID: 1843462 DOI: [10.1034/j.1600-0501.1991.020309.x](https://doi.org/10.1034/j.1600-0501.1991.020309.x)
- 13.Rompen E, Domken O, Degidi M, Pontes AE, Piattelli A. The effect of material characteristics, of surface topography and of implant components and connections on soft tissue integration: a literature review. *Clin Oral Implants Res* 2006;17 Suppl 2:55-67. PMID: 16968382 DOI: [10.1111/j.1600-0501.2006.01367.x](https://doi.org/10.1111/j.1600-0501.2006.01367.x)
- 14.Klinge B, Meyle J; Working Group 2. Soft-tissue integration of implants. Consensus report of Working Group 2. *Clin Oral Implants Res* 2006;17 Suppl 2:93-6. PMID: 16968385 DOI: [10.1111/j.1600-0501.2006.001366.x](https://doi.org/10.1111/j.1600-0501.2006.001366.x)

Wound healing: Osseointegration

- 1.Berglundh T, Abrahamsson I, Lang NP, Lindhe J. De novo alveolar bone formation adjacent to endosseous implants. *Clin Oral Implants Res.* 2003 Jun;14(3):251-62. PMID: 12755774 DOI: [10.1034/j.1600-0501.2003.00972.x](https://doi.org/10.1034/j.1600-0501.2003.00972.x).
- 2.Abrahamsson I, Berglundh T, Linder E, Lang NP, Lindhe J. Early bone formation adjacent to rough and turned endosseous implant surfaces. An experimental study in the dog. *Clin Oral Implants Res.* 2004 Aug;15(4):381-92. PMID: 15248872 DOI: [10.1111/j.1600-0501.2004.01082.x](https://doi.org/10.1111/j.1600-0501.2004.01082.x).
- 3.Berglundh T, Lindhe J, Ericsson I, Marinello CP, Liljenberg B, Thomsen P. The soft tissue barrier at implants and teeth. *Clin Oral Implants Res.* 1991 Apr-Jun;2(2):81-90. PMID: 1809403 DOI: [10.1034/j.1600-0501.1991.020206.x](https://doi.org/10.1034/j.1600-0501.1991.020206.x).
- 4.Berglundh T, Lindhe J, Jonsson K, Ericsson I. The topography of the vascular systems in the periodontal and peri-implant tissues in the dog. *J Clin Periodontol.* 1994 Mar;21(3):189-93. PMID: 8157772 DOI: [10.1111/j.1600-051x.1994.tb00302.x](https://doi.org/10.1111/j.1600-051x.1994.tb00302.x).
- 5.Berglundh T, Lindhe J. Dimension of the periimplant mucosa. Biological width revisited. *J Clin Periodontol.* 1996 Oct;23(10):971-3. PMID: 8915028 DOI: [10.1111/j.1600-051x.1996.tb00520.x](https://doi.org/10.1111/j.1600-051x.1996.tb00520.x).
- 6.Berglundh T, Abrahamsson I, Welander M, Lang NP, Lindhe J. Morphogenesis of the peri-implant mucosa: an experimental study in dogs. *Clin Oral Implants Res.* 2007 Feb;18(1):1-8. PMID: 17224016 DOI: [10.1111/j.1600-0501.2006.01380.x](https://doi.org/10.1111/j.1600-0501.2006.01380.x).
- 7.Botticelli D, Berglundh T, Lindhe J. Resolution of bone defects of varying dimension and configuration in the marginal portion of the peri-implant bone. An experimental study in the dog. *J Clin Periodontol.* 2004 Apr;31(4):309-17. PMID: 15016260 DOI: [10.1111/j.1600-051X.2004.00502.x](https://doi.org/10.1111/j.1600-051X.2004.00502.x).
- 8.Araújo MG, Sukekava F, Wennström JL, Lindhe J. Tissue modeling following implant placement in fresh extraction sockets. *Clin Oral Implants Res.* 2006 Dec;17(6):615-24. PMID: 17092218 DOI: [10.1111/j.1600-0501.2006.01317.x](https://doi.org/10.1111/j.1600-0501.2006.01317.x).

9. Tomasi C, Tessarolo F, Caola I, Piccoli F, Wennström JL, Nollo G, Berglundh T. Early healing of peri-implant mucosa in man. *J Clin Periodontol.* 2016 Oct;43(10):816-24. PMID: 27329966 DOI: 10.1111/jcpe.12591.
10. Albrektsson T, Wennerberg A. On osseointegration in relation to implant surfaces. *Clin Implant Dent Relat Res.* 2019 Mar;21 Suppl 1:4-7. PMID: 30816639 DOI: 10.1111/cid.12742.

19.2 Peri-implant examination

Questions to be answered from this section:

- How do you compare periodontal and peri-implant probing depths?
- What is the ideal distance and bone height required around implants?
- What are the dimensions of peri-implant mucosa?
- What is the role of keratinized gingiva around implants?

1. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. *J Periodontol.* 1992 Dec;63(12):995-6. PMID: 1474471 DOI: 10.1902/jop.1992.63.12.995.
2. Mombelli A, Mühle T, Brägger U, Lang NP, Bürgin WB. Comparison of periodontal and peri-implant probing by depth-force pattern analysis. *Clin Oral Implants Res.* 1997 Dec;8(6):448-54. PMID: 9555203 DOI: 10.1034/j.1600-0501.1997.080602.x.
3. Spray JR, Black CG, Morris HF, Ochi S. The influence of bone thickness on facial marginal bone response: stage 1 placement through stage 2 uncovering. *Ann Periodontol.* 2000 Dec;5(1):119-28. PMID: 11885170 DOI: 10.1902/annals.2000.5.1.119.
4. Tarnow D, Cho S, et al. The effect of inter-implant distance on the height of inter-implant bone crest. *J Periodontol.* 2000;71:546-549. PMID: 10807116 DOI: 10.1902/jop.2000.71.4.546.
5. Tarnow D, Elian N, Fletcher P, Froum S, Magner A, Cho SC, Salama M, Salama H, Garber DA. Vertical Distance from the Crest of Bone to the Height of the Interproximal Papilla between Adjacent Implants. *J Periodontol.* 2003;74(12):1785-1788. PMID: 14974820 DOI: 10.1902/jop.2003.74.12.1785.
6. Kan JY, Rungcharassaeng K, Umez K, Kois JC. Dimensions of peri-implant mucosa: an evaluation of maxillary anterior single implants in humans. *J Periodontol.* 2003 Apr;74(4):557-62. PMID: 12747463 DOI: 10.1902/jop.2003.74.4.557.
7. Gastaldo J, Cury P, Sendyk W. Effect of the vertical and horizontal distances between adjacent implants and between a tooth and an implant on the incidence of interproximal papilla. *J Periodontol.* 2004;75:1242-1246. PMID: 15515340 DOI: 10.1902/jop.2004.75.9.1242.
8. Lin GH, Chan HL, Wang HL. The Significance of Keratinized Mucosa on Implant Health: A Systematic Review. *J Periodontol.* 2013;84:1755–1767. PMID: 23451989 DOI: 10.1902/jop.2013.120688.
9. Cochran DL, Obrecht M, Weber K, Dard M, Bosshardt D, Higginbottom FL, Wilson TG Jr, Jones AA. Biologic width adjacent to loaded implants with machined and rough collars in the dog. *Int J Periodontics Restorative Dent.* 2014 Nov-Dec;34(6):773-9. PMID: 25411732 DOI: 10.11607/prd.1990.
10. Halperin-Sternfeld M, Zigdon-Giladi H, Machtei EE. The association between shallow vestibular depth and peri-implant parameters: a retrospective 6 years longitudinal study. *J Clin Periodontol.* 2016 Mar;43(3):305-10. PMID: 26718112 DOI: 10.1111/jcpe.12504.

Questions to be answered from this section:

- How important is occlusion on implants?
- Does occlusion have any effect on peri-implant health?
- Does occlusion play any role on the treatment of peri-implant mucositis and/or peri-implantitis?

1. Bozkaya D, Muftu S, Muftu A. Evaluation of load transfer characteristics of five different implants in compact bone at different load levels by finite elements analysis. *J Prosthet Dent.* 2004;92(6):523-530. doi:10.1016/j.prosdent.2004.07.024
2. Duyck J, Van Oosterwyck H, Vander Sloten J, De Cooman M, Puers R, Naert I. Magnitude and distribution of occlusal forces on oral implants supporting fixed prostheses: an in vivo study. *Clin Oral Implants Res.* 2000;11(5):465-475. doi:10.1034/j.1600-0501.2000.011005465.x
3. Hudieb MI, Wakabayashi N, Kasugai S. Magnitude and direction of mechanical stress at the osseointegrated interface of the microthread implant. *J Periodontol.* 2011;82(7):1061-1070. doi:10.1902/jop.2010.100237
4. Isidor F. Influence of forces on peri-implant bone. *Clin Oral Implants Res.* 2006;17 Suppl 2:8-18. doi:10.1111/j.1600-0501.2006.01360.x
5. Kim Y, Oh TJ, Misch CE, Wang HL. Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. *Clin Oral Implants Res.* 2005;16(1):26-35. doi:10.1111/j.1600-0501.2004.01067.x
6. Rungsiyakull C, Rungsiyakull P, Li Q, Li W, Swain M. Effects of occlusal inclination and loading on mandibular bone remodeling: a finite element study. *Int J Oral Maxillofac Implants.* 2011;26(3):527-537.

Review:

7. Goldstein G, Goodacre C, Taylor T. Occlusal Schemes for Implant Restorations: Best Evidence Consensus Statement. *J Prosthodont.* 2021;30(S1):84-90. doi:10.1111/jopr.13319
8. Sheridan RA, Decker AM, Plonka AB, Wang HL. The Role of Occlusion in Implant Therapy: A Comprehensive Updated Review. *Implant Dent.* 2016;25(6):829-838. doi:10.1097/ID.0000000000000488

19.4 Cement vs Screw-Retained Prosthesis

Questions to be answered from this section:

- Does cemented or screwed retained restorations have any impact on peri-implant mucositis/peri-implantitis?

1. Linkevicius T, Puisys A, Vindasiute E, Linkeviciene L, Apse P. Does residual cement around implant-supported restorations cause peri-implant disease? A retrospective case analysis. *Clin Oral Implants Res.* 2013;24(11):1179-1184. doi:10.1111/j.1600-0501.2012.02570.x
2. Linkevicius T, Vindasiute E, Puisys A, Linkeviciene L, Maslova N, Puriene A. The influence of the cementation margin position on the amount of undetected cement. A prospective clinical study. *Clin Oral Implants Res.* 2013;24(1):71-76. doi:10.1111/j.1600-0501.2012.02453.x
3. Wilson TG Jr. The positive relationship between excess cement and peri-implant disease: a prospective clinical endoscopic study. *J Periodontol.* 2009;80(9):1388-1392. doi:10.1902/jop.2009.090115

Reviews:

1. de Brandão ML, Vettore MV, Vidigal Júnior GM. Peri-implant bone loss in cement- and screw-retained prostheses: systematic review and meta-analysis. *J Clin Periodontol.* 2013;40(3):287-295. doi:10.1111/jcpe.12041

2. Wittneben JG, Millen C, Brägger U. Clinical performance of screw- versus cement-retained fixed implant-supported reconstructions--a systematic review. *Int J Oral Maxillofac Implants*. 2014;29 Suppl:84-98. doi:10.11607/jomi.2014suppl.g2.1
3. Kraus RD, Espuelas C, Hämmeterle CHF, Jung RE, Sailer I, Thoma DS. Five-year randomized controlled clinical study comparing cemented and screw-retained zirconia-based implant-supported single crowns. *Clin Oral Implants Res*. 2022;33(5):537-547. doi:10.1111/clr.13913

19.5 Implant Loading Time Protocols

Questions to be answered from this section:

- When can an implant be loaded?
- What is immediate loading, and when should it be used?
- What are the tissue responses to immediate loading?

1. Barone A, Covani U, Cornelini R, Gherlone E. Radiographic bone density around immediately loaded oral implants. *Clin Oral Implants Res*. 2003;14(5):610-615.
2. Bornstein MM, Hart CN, Halbritter SA, Morton D, Buser D. Early loading of nonsubmerged titanium implants with a chemically modified sand-blasted and acid-etched surface: 6-month results of a prospective case series study in the posterior mandible focusing on peri-implant crestal bone changes and implant stability quotient (ISQ) values. *Clin Implant Dent Relat Res*. 2009;11(4):338-347.
3. Bornstein MM, Schmid B, Belser UC, Lussi A, Buser D. Early loading of non-submerged titanium implants with a sandblasted and acid-etched surface. 5-year results of a prospective study in partially edentulous patients. *Clin Oral Implants Res*. 2005;16(6):631-638.
4. Cochran DL, Hermann JS, Schenk RK, Higginbottom FL, Buser D. Biologic width around titanium implants. A histometric analysis of the implanto-gingival junction around unloaded and loaded nonsubmerged implants in the canine mandible. *J Periodontol*. 1997;68(2):186-198.
5. Cornelini R, Cangini F, Covani U, Barone A, Buser D. Immediate loading of implants with 3-unit fixed partial dentures: a 12-month clinical study. *Int J Oral Maxillofac Implants*. 2006;21(6):914-918.
6. Delgado-Ruiz RA, Calvo-Guirado JL, Romanos GE. Effects of occlusal forces on the peri-implant-bone interface stability. *Periodontol 2000*. 2019;81(1):179-193.
7. Donati M, La Scala V, Billi M, Di Dino B, Torrisi P, Berglundh T. Immediate functional loading of implants in single tooth replacement: a prospective clinical multicenter study. *Clin Oral Implants Res*. 2008;19(7):740-748.
8. Eser A, Akça K, Eckert S, Cehreli MC. Nonlinear finite element analysis versus ex vivo strain gauge measurements on immediately loaded implants. *Int J Oral Maxillofac Implants*. 2009;24(3):439-446.
9. Romanos G, Toh CG, Siar CH, et al. Peri-implant bone reactions to immediately loaded implants. An experimental study in monkeys. *J Periodontol*. 2001;72(4):506-511.
10. van Steenberghe D, Naert I, Andersson M, Brajnovic I, Van Cleynenbreugel J, Suetens P. A custom template and definitive prosthesis allowing immediate implant loading in the maxilla: a clinical report. *Int J Oral Maxillofac Implants*. 2002;17(5):663-670.
11. Tarnow DP, Chu SJ, Salama MA, et al. Flapless postextraction socket implant placement in the esthetic zone: part 1. The effect of bone grafting and/or provisional restoration on facial-palatal ridge dimensional change-a retrospective cohort study. *Int J Periodontics Restorative Dent*. 2014;34(3):323-331.
12. Zembić A, Glauser R, Khraisat A, Hämmeterle CH. Immediate vs. early loading of dental implants: 3-year results of a randomized controlled clinical trial. *Clin Oral Implants Res*. 2010;21(5):481-489.

Reviews:

1. Atieh MA, Payne AG, Duncan WJ, de Silva RK, Cullinan MP. Immediate placement or immediate restoration/loading of single implants for molar tooth replacement: a systematic review and meta-analysis. *Int J Oral Maxillofac Implants*. 2010;25(2):401-415.
2. Cochran DL. The evidence for immediate loading of implants. *J Evid Based Dent Pract*. 2006;6(2):155-163.

3. De Bruyn H, Raes S, Ostman PO, Cosyn J. Immediate loading in partially and completely edentulous jaws: a review of the literature with clinical guidelines. *Periodontol 2000*. 2014;66(1):153-187.
4. Esposito M, Grusovin MG, Willings M, Coulthard P, Worthington HV. The effectiveness of immediate, early, and conventional loading of dental implants: a Cochrane systematic review of randomized controlled clinical trials. *Int J Oral Maxillofac Implants*. 2007;22(6):893-904.
5. Glauser R, Zembic A, Hämmерle CH. A systematic review of marginal soft tissue at implants subjected to immediate loading or immediate restoration. *Clin Oral Implants Res*. 2006;17 Suppl 2:82-92.
6. Morton D, Pollini A. Evolution of loading protocols in implant dentistry for partially dentate arches. *Periodontol 2000*. 2017;73(1):152-177.
7. Romanos GE. Wound healing in immediately loaded implants. *Periodontol 2000*. 2015;68(1):153-167.

19.6 Implant-Abutment Connection & Platform Switching

Questions to be answered from this section:

- What are the tissue responses to the implant-abutment connection?
- What is platform switching, and how does it affect peri-implant hard and soft tissues?

1. Canullo L, Fedele GR, Iannello G, Jepsen S. Platform switching and marginal bone-level alterations: the results of a randomized-controlled trial. *Clin Oral Implants Res*. 2010;21:115-121.
2. Canullo L, Penarrocha-Oltra D, Soldini C, Mazzocco F, Penarrocha M, Covani U. Microbiological assessment of the implant-abutment interface in different connections: cross-sectional study after 5 years of functional loading. *Clin Oral Implants Res*. 2015;26:426-434.
3. Cappiello M, Luongo R, Di Iorio D, Bugea C, Cocchetto R, Celletti R. Evaluation of peri-implant bone loss around platform-switched implants. *Int J Periodontics Restorative Dent*. 2008;28:347-355.
4. Gardner DM. Platform switching as a means to achieving implant esthetics. *N Y State Dent J*. 2005;71:34-37.
5. Hudieb MI, Wakabayashi N, Kasugai S. Magnitude and direction of mechanical stress at the osseointegrated interface of the microthread implant. *J Periodontol*. 2011;82:1061-1070.
6. Hürzeler M, Fickl S, Zuhr O, Wachtel HC. Peri-implant bone level around implants with platform-switched abutments: preliminary data from a prospective study. *J Oral Maxillofac Surg*. 2007;65:33-39.
7. Lazzara RJ, Porter SS. Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels. *Int J Periodontics Restorative Dent*. 2006;26:9-17.
8. Nevins M, Camelo M, Koo S, Lazzara RJ, Kim DM. Human histologic assessment of a platform-switched osseointegrated dental implant. *Int J Periodontics Restorative Dent*. 2014;34 Suppl 3:s71-73.
9. Pieri F, Aldini NN, Marchetti C, Corinaldesi G. Influence of implant-abutment interface design on bone and soft tissue levels around immediately placed and restored single-tooth implants: a randomized controlled clinical trial. *Int J Oral Maxillofac Implants*. 2011;26:169-178.
10. Rodríguez-Ciurana X, Vela-Nebot X, Segalà-Torres M, et al. The effect of interimplant distance on the height of the interimplant bone crest when using platform-switched implants. *Int J Periodontics Restorative Dent*. 2009;29:141-151.
11. Schrotenboer J, Tsao YP, Kinariwala V, Wang HL. Effect of microthreads and platform switching on crestal bone stress levels: a finite element analysis. *J Periodontol*. 2008;79:2166-2172.
12. Su H, Gonzalez-Martin O, Weisgold A, Lee E. Considerations of implant abutment and crown contour: critical contour and subcritical contour. *Int J Periodontics Restorative Dent*. 2010;30:335-343.
13. Tabata LF, Rocha EP, Barão VA, Assunção WG. Platform switching: biomechanical evaluation using three-dimensional finite element analysis. *Int J Oral Maxillofac Implants*. 2011;26:482-491.
14. Wennerberg A, Sennerby L, Kultje C, Lekholm U. Some soft tissue characteristics at implant abutments with different surface topography. A study in humans. *J Clin Periodontol*. 2003;30:88-94.

Reviews:

1. Annibali S, Bignozzi I, Cristalli MP, Graziani F, La Monaca G, Polimeni A. Peri-implant marginal bone

- level: a systematic review and meta-analysis of studies comparing platform switching versus conventionally restored implants. *J Clin Periodontol.* 2012;39:1097-1113.
2. Strietzel FP, Neumann K, Hertel M. Impact of platform switching on marginal peri-implant bone-level changes. A systematic review and meta-analysis. *Clin Oral Implants Res.* 2015;26:342-358.
 3. Tomar S, Saxena D, Kaur N. Marginal bone loss around implants with platform switching and platform matched connection: A systematic review. *J Prosthet Dent.* Published online October 18, 2023. doi:10.1016/j.prosdent.2023.09.009

19.7 Implant-Supported Prosthetic Considerations

Questions to be answered from this section:

- What are some of the possible implant prosthetic complications?
- What are the long-term survival/success rates of implant-supported prostheses?
- What is the influence of the crown-to-implant ratio?

1. Eliasson A, Eriksson T, Johansson A, Wennerberg A. Fixed partial prostheses supported by 2 or 3 implants: a retrospective study up to 18 years. *Int J Oral Maxillofac Implants.* 2006;21:567-574.
2. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications with implants and implant prostheses. *J Prosthet Dent.* 2003;90:121-132.
3. Gross M, Laufer BZ. Splinting osseointegrated implants and natural teeth in rehabilitation of partially edentulous patients. Part I: laboratory and clinical studies. *J Oral Rehabil.* 1997;24:863-870.
4. Kan JY, Rungcharassaeng K, Umezu K, Kois JC. Dimensions of peri-implant mucosa: an evaluation of maxillary anterior single implants in humans. *J Periodontol.* 2003;74:557-562.
5. Katafuchi M, Weinstein BF, Leroux BG, Chen YW, Daubert DM. Restoration contour is a risk indicator for peri-implantitis: A cross-sectional radiographic analysis. *J Clin Periodontol.* 2018;45:225-232.
6. Kim P, Ivanovski S, Latcham N, Mattheos N. The impact of cantilevers on biological and technical success outcomes of implant-supported fixed partial dentures. A retrospective cohort study. *Clin Oral Implants Res.* 2014;25:175-184.
7. Lang NP, Pjetursson BE, Tan K, Brägger U, Egger M, Zwahlen M. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years. II. Combined tooth--implant-supported FPDs. *Clin Oral Implants Res.* 2004;15:643-653.
8. Laufer BZ, Gross M. Splinting osseointegrated implants and natural teeth in rehabilitation of partially edentulous patients. Part II: principles and applications. *J Oral Rehabil.* 1998;25:69-80.
9. Pieri F, Aldini NN, Marchetti C, Corinaldesi G. Influence of implant-abutment interface design on bone and soft tissue levels around immediately placed and restored single-tooth implants: a randomized controlled clinical trial. *Int J Oral Maxillofac Implants.* 2011;26:169-178.
10. Ravidà A, Tattan M, Askar H, Barootchi S, Tavelli L, Wang HL. Comparison of three different types of implant-supported fixed dental prostheses: A long-term retrospective study of clinical outcomes and cost-effectiveness. *Clin Oral Implants Res.* 2019;30:295-305.
11. Romeo E, Tomasi C, Finini I, Casentini P, Lops D. Implant-supported fixed cantilever prosthesis in partially edentulous jaws: a cohort prospective study. *Clin Oral Implants Res.* 2009;20:1278-1285.
12. Walton TR. An Up-to-15-Year Comparison of the Survival and Complication Burden of Three-Unit Tooth-Supported Fixed Dental Prostheses and Implant-Supported Single Crowns. *Int J Oral Maxillofac Implants.* 2015;30:851-861.

Reviews:

1. Chee WW. Provisional restorations in soft tissue management around dental implants. *Periodontol 2000.* 2001;27:139-147.
2. Garaicoa-Pazmiño C, Suárez-López del Amo F, Monje A, et al. Influence of crown/implant ratio on marginal bone loss: a systematic review. *J Periodontol.* 2014;85:1214-1221.
3. Greenstein G, Cavallaro J, Smith R, Tarnow D. Connecting teeth to implants: a critical review of the 107

literature and presentation of practical guidelines. *Compend Contin Educ Dent.* 2009;30:440-453.

4. Papaspyridakos P, Chen CJ, Chuang SK, Weber HP, Gallucci GO. A systematic review of biologic and technical complications with fixed implant rehabilitations for edentulous patients. *Int J Oral Maxillofac Implants.* 2012;27:102-110.

19.8 Contraindications for Implant Therapy

1. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int J Oral Maxillofac Implants.* 1986;1:11-25. PMID: 3527955
2. Friberg B, Jemt T, Lekholm U. Early failures in 4,641 consecutively placed Bränemark dental implants: a study from stage 1 surgery to the connection of completed prostheses. *Int J Oral Maxillofac Implants.* 1991;6:142-146. PMID: 1809668
3. Albrektsson T. On long-term maintenance of the osseointegrated response. *Aust Prosthodont J.* 1993;7 Suppl:15-24. PMID: 8054223
4. Bain CA, Moy PK. The association between the failure of dental implants and cigarette smoking. *Int J Oral Maxillofac Implants.* 1993;8:609-615. PMID: 8181822
5. De Bruyn H, Collaert B. The effect of smoking on early implant failure. *Clin Oral Implants Res.* 1994;5:260-264. doi: 10.1034/j.1600-0501.1994.050410.x. PMID: 7640341.
6. Weyant RJ. Characteristics associated with the loss and peri-implant tissue health of endosseous dental implants. *Int J Oral Maxillofac Implants.* 1994;9:95-102. PMID: 8150519
7. Albrektsson TO, Johansson CB, Sennerby L. Biological aspects of implant dentistry: osseointegration. *Periodontol 2000.* 1994;4:58-73 doi: 10.1111/j.1600-0757.1994.tb00006.x. PMID: 9673194.
8. Cronin RJ, Jr., Oesterle LJ. Implant use in growing patients. Treatment planning concerns. *Dent Clin North Am.* 1998;42:1-34. PMID: 9421667
9. Schincaglia GP, Nowzari H. Surgical treatment planning for the single-unit implant in aesthetic areas. *Periodontol 2000.* 2001;27:162-182 doi: 10.1034/j.1600-0757.2001.027001162.x. PMID: 11551307.
10. Sugerman PB, Barber MT. Patient selection for endosseous dental implants: oral and systemic considerations. *Int J Oral Maxillofac Implants.* 2002;17:191-201. PMID: 11958401
11. Hwang D, Wang HL. Medical contraindications to implant therapy: part I: absolute contraindications. *Implant Dent.* 2006;15:353-360 doi: 10.1097/01.id.0000247855.75691.03. PMID: 17172952.
12. Heij DG, Opdebeeck H, van Steenberghe D, Kokich VG, Belser U, Quirynen M. Facial development, continuous tooth eruption, and mesial drift as compromising factors for implant placement. *Int J Oral Maxillofac Implants.* 2006;21:867-878. PMID: 17190296
13. Fudalej P, Kokich VG, Leroux B. Determining the cessation of vertical growth of the craniofacial structures to facilitate placement of single-tooth implants. *Am J Orthod Dentofacial Orthop.* 2007;131:S59-67. doi: 10.1016/j.ajodo.2006.07.022. PMID: 17448387.
14. Funato A, Salama MA, Ishikawa T, Garber DA, Salama H. Timing, positioning, and sequential staging in esthetic implant therapy: a four-dimensional perspective. *Int J Periodontics Restorative Dent.* 2007;27:313-323. PMID: 17726987
15. Holahan CM, Koka S, Kennel KA, et al. Effect of osteoporotic status on the survival of titanium dental implants. *Int J Oral Maxillofac Implants.* 2008;23:905-910. PMID: 19014161
16. Hwang D, Wang HL. Medical contraindications to implant therapy: Part II: Relative contraindications. *Implant Dent.* 2007;16:13-23. doi: 10.1097/ID.0b013e31803276c8. PMID: 17356368.
17. Fugazzotto PA, Lightfoot WS, Jaffin R, Kumar A. Implant placement with or without simultaneous tooth extraction in patients taking oral bisphosphonates: postoperative healing, early follow-up, and the incidence of complications in two private practices. *J Periodontol.* 2007;78:1664-1669. doi: 10.1902/jop.2007.060514. PMID: 17760533.
18. Machtei EE, Mahler D, Oettinger-Barak O, Zuabi O, Horwitz J. Dental implants placed in previously failed sites: survival rate and factors affecting the outcome. *Clin Oral Implants Res.* 2008;19:259-264. doi: 10.1111/j.1600-0501.2007.01466.x. PMID: 18177430.

19. Roccuzzo M, De Angelis N, Bonino L, Aglietta M. Ten-year results of a three-arm prospective cohort study on implants in periodontally compromised patients. Part 1: implant loss and radiographic bone loss. *Clin Oral Implants Res.* 2010;21:490-496. doi: 10.1111/j.1600-0501.2009.01886.x. PMID: 20337668.
20. Levin L, Ofec R, Grossmann Y, Anner R. Periodontal disease as a risk for dental implant failure over time: a long-term historical cohort study. *J Clin Periodontol.* 2011;38:732-737. doi: 10.1111/j.1600-051X.2011.01745.x. PMID: 21635280.
21. Machtei EE, Horwitz J, Mahler D, Grossmann Y, Levin L. Third attempt to place implants in sites where previous surgeries have failed. *J Clin Periodontol.* 2011;38:195-198. doi: 10.1111/j.1600-051X.2010.01629.x. PMID: 20958341.
22. Roccuzzo M, Bonino F, Aglietta M, Dalmasso P. Ten-year results of a three arms prospective cohort study on implants in periodontally compromised patients. Part 2: clinical results. *Clin Oral Implants Res.* 2012;23:389-395. doi: 10.1111/j.1600-0501.2011.02309.x. PMID: 22092445.
23. Fugazzotto PA. A retrospective analysis of implants immediately placed in sites with and without periapical pathology in sixty-four patients. *J Periodontol.* 2012;83:182-186. doi: 10.1902/jop.2011.110016. PMID: 21627462.
24. Swierkot K, Lottholz P, Flores-de-Jacoby L, Mengel R. Mucositis, peri-implantitis, implant success, and survival of implants in patients with treated generalized aggressive periodontitis: 3- to 16-year results of a prospective long-term cohort study. *J Periodontol.* 2012;83:1213-1225. doi: 10.1902/jop.2012.110603. PMID: 22264211.
25. Diz P, Scully C, Sanz M. Dental implants in the medically compromised patient. *J Dent.* 2013;41:195-206. doi: 10.1016/j.jdent.2012.12.008. PMID: 23313715.
26. Roccuzzo M, Bonino L, Dalmasso P, Aglietta M. Long-term results of a three arms prospective cohort study on implants in periodontally compromised patients: 10-year data around sandblasted and acid-etched (SLA) surface. *Clin Oral Implants Res.* 2014;25:1105-1112. doi: 10.1111/clr.12227. PMID: 23865554.
27. Gomez-de Diego R, Mang-de la Rosa Mdel R, Romero-Perez MJ, Cutando-Soriano A, Lopez-Valverde-Centeno A. Indications and contraindications of dental implants in medically compromised patients: update. *Med Oral Patol Oral Cir Bucal.* 2014;19:e483-489. doi: 10.4317/medoral.19565. PMID: 24608222; PMCID: PMC4192572.
28. Rasperini G, Siciliano VI, Cafiero C, Salvi GE, Blasi A, Aglietta M. Crestal bone changes at teeth and implants in periodontally healthy and periodontally compromised patients. A 10-year comparative case-series study. *J Periodontol.* 2014;85:e152-159. doi: 10.1902/jop.2013.130415. PMID: 24215202.
29. Derks J, Hakansson J, Wennstrom JL, Tomasi C, Larsson M, Berglundh T. Effectiveness of implant therapy analyzed in a Swedish population: early and late implant loss. *J Dent Res.* 2015;94:44S-51S. doi: 10.1177/0022034514563077. PMID: 25503901; PMCID: PMC4541089.
30. Gomez-Moreno G, Aguilar-Salvatierra A, Rubio Roldan J, Guardia J, Gargallo J, Calvo-Guirado JL. Peri-implant evaluation in type 2 diabetes mellitus patients: a 3-year study. *Clin Oral Implants Res.* 2015;26:1031-1035. doi: 10.1111/clr.12391. PMID: 24684438.
31. Ouanounou A, Hassanpour S, Glogauer M. The influence of systemic medications on osseointegration of dental implants. *J Can Dent Assoc.* 2016;82:g7. PMID: 27548672.
32. Chrcanovic BR, Kisch J, Albrektsson T, Wennerberg A. Factors Influencing Early Dental Implant Failures. *J Dent Res.* 2016;95:995-1002. doi: 10.1177/0022034516646098. PMID: 27146701.

33. Chrcanovic BR, Kisch J, Albrektsson T, Wennerberg A. Intake of Proton Pump Inhibitors Is Associated with an Increased Risk of Dental Implant Failure. *Int J Oral Maxillofac Implants*. 2017;32:1097–1102. doi: 10.11607/jomi.5662. Epub 2017 Jun 20. PMID: 28632255.
34. Eskow CC, Oates TW. Dental Implant Survival and Complication Rate over 2 Years for Individuals with Poorly Controlled Type 2 Diabetes Mellitus. *Clin Implant Dent Relat Res*. 2017;19:423–431. doi: 10.1111/cid.12465. Epub 2016 Dec 19. PMID: 27990756; PMCID: PMC5453839.
35. Smith MM, Knight ET, Al-Harthi L, Leichter JW. Chronic periodontitis and implant dentistry. *Periodontol 2000*. 2017;74:63–73. doi: 10.1111/prd.12190. PMID: 28429486.
36. Curi MM, Condezo AFB, Ribeiro K, Cardoso CL. Long-term success of dental implants in patients with head and neck cancer after radiation therapy. *Int J Oral Maxillofac Surg*. 2018;47:783–788. doi: 10.1016/j.ijom.2018.01.012. Epub 2018 Feb 6. PMID: 29426738.
37. Javed F, Romanos GE. Chronic hyperglycemia as a risk factor in implant therapy. *Periodontol 2000*. 2019;81:57–63. doi: 10.1111/prd.12283. PMID: 31407442.
38. Javed F, Rahman I, Romanos GE. Tobacco-product usage as a risk factor for dental implants. *Periodontol 2000*. 2019;81:48–56. doi: 10.1111/prd.12282. PMID: 31407428.
39. Aghaloo T, Pi-Anfruns J, Moshaverinia A, Sim D, Grogan T, Hadaya D. The Effects of Systemic Diseases and Medications on Implant Osseointegration: A Systematic Review. *Int J Oral Maxillofac Implants*. 2019;34:s35–s49. doi: 10.11607/jomi.19suppl.g3. PMID: 31116832.
40. Romanos GE, Delgado-Ruiz R, Sculean A. Concepts for prevention of complications in implant therapy. *Periodontol 2000*. 2019;81:7–17. doi: 10.1111/prd.12278. PMID: 31407435.
41. Hakam AE, Vila G, Duarte PM, et al. Effects of different antidepressant classes on dental implant failure: A retrospective clinical study. *J Periodontol*. 2021;92:196–204. doi: 10.1002/JPER.19-0714. Epub 2020 Aug 14. PMID: 32725908.
42. Kotsakis GA, Romanos GE. Biological mechanisms underlying complications related to implant site preparation. *Periodontol 2000*. 2022;88:52–63. doi: 10.1111/prd.12410. PMID: 35103318.
43. Schliephake H. The role of systemic diseases and local conditions as risk factors. *Periodontol 2000*. 2022;88:36–51. doi: 10.1111/prd.12409. PMID: 35103330.

Reviews:

44. Colella G, Cannavale R, Pentenero M, Gandolfo S. Oral implants in radiated patients: a systematic review. *Int J Oral Maxillofac Implants*. 2007;22:616–622. PMID: 17929523
45. Monje A, Catena A, Borgnakke WS. Association between diabetes mellitus/hyperglycaemia and peri-implant diseases: Systematic review and meta-analysis. *J Clin Periodontol*. 2017;44:636–648. doi: 10.1111/jcpe.12724. Epub 2017 May 5. PMID: 28346753
46. Stavropoulos A, Bertl K, Pietschmann P, Pandis N, Schiodt M, Klinge B. The effect of antiresorptive drugs on implant therapy: Systematic review and meta-analysis. *Clin Oral Implants Res*. 2018;29 Suppl 18:54–92. doi: 10.1111/clr.13282. PMID: 30306695
47. Chappuis V, Avila-Ortiz G, Araujo MG, Monje A. Medication-related dental implant failure: Systematic review and meta-analysis. *Clin Oral Implants Res*. 2018;29 Suppl 16:55–68. doi: 10.1111/clr.13137. PMID: 30328197

48. Aghaloo T, Pi-Anfruns J, Moshaverinia A, Sim D, Grogan T, Hadaya D. The Effects of Systemic Diseases and Medications on Implant Osseointegration: A Systematic Review. *Int J Oral Maxillofac Implants*. 2019;34:s35-s49. doi: 10.11607/jomi.19suppl.g3. PMID: 31116832
49. Naseri R, Yaghini J, Feizi A. Levels of smoking and dental implants failure: A systematic review and meta-analysis. *J Clin Periodontol*. 2020;47:518-528. doi: 10.1111/jcpe.13257. Epub 2020 Feb 7. PMID: 31955453

19.9 Implant Designs (macro- and micro-designs)

Questions to be answered from this section:

- What are the implant surface modification methods?
- What is the goal of an implant surface modification method?
- How does the implant macro or micro-design affect its success/survival rates?
- Are some implant macro or micro-designs superior in certain clinical scenarios?

Surface modifications: additive vs. subtractive methods

1. Bränemark PI, Hansson BO, Adell R, et al. Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period. *Scand J Plast Reconstr Surg Suppl*. 1977;16:1-132. PMID: 356184
2. Adell R, Lekholm U, Rockler B, Bränemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. *Int J Oral Surg*. 1981;10:387-416. doi: 10.1016/s0300-9785(81)80077-4. PMID: 6809663.
3. Albrektsson T, Jacobsson M. Bone-metal interface in osseointegration. *J Prosthet Dent*. 1987;57:597-607. doi: 10.1016/0022-3913(87)90344-1. PMID: 3298630.
4. Rams TE, Roberts TW, Feik D, Molzan AK, Slots J. Clinical and microbiological findings on newly inserted hydroxyapatite-coated and pure titanium human dental implants. *Clin Oral Implants Res*. 1991;2:121-127. doi: 10.1034/j.1600-0501.1991.020304.x. PMID: 1843465.
5. Buser D, Schenk RK, Steinemann S, Fiorellini JP, Fox CH, Stich H. Influence of surface characteristics on bone integration of titanium implants. A histomorphometric study in miniature pigs. *J Biomed Mater Res*. 1991;25:889-902. doi: 10.1002/jbm.820250708. PMID: 1918105.
6. Davies JE. Mechanisms of endosseous integration. *Int J Prosthodont*. 1998;11(5):391-401. PMID: 9922731
7. Albrektsson T, Wennerberg A. Oral implant surfaces: Part 1--review focusing on topographic and chemical properties of different surfaces and in vivo responses to them. *Int J Prosthodont*. 2004;17:536-543. PMID: 15543910
8. Cheng GJ, Pirzada D, Cai M, Mohanty P, Bandyopadhyay A. Bioceramic coating of hydroxyapatite on titanium substrate with Nd-YAG laser. *Materials Science and Engineering: C*. 2005;25:541-547. DOI: 10.1016/j.msec.2005.05.002
9. Sul YT, Johansson C, Wennerberg A, Cho LR, Chang BS, Albrektsson T. Optimum surface properties of oxidized implants for reinforcement of osseointegration: surface chemistry, oxide thickness, porosity, roughness, and crystal structure. *Int J Oral Maxillofac Implants*. 2005;20:349-359. PMID: 15973946.
10. Schwartz Z, Nasazky E, Boyan BD. Surface microtopography regulates osteointegration: the role of implant surface microtopography in osteointegration. *Alpha Omega*. 2005;98:9-19. PMID: 16122142
11. Sennerby L, Meredith N. Implant stability measurements using resonance frequency analysis: biological and biomechanical aspects and clinical implications. *Periodontol 2000*. 2008;47:51-66. doi: 10.1111/j.1600-0757.2008.00267.x. PMID: 18412573.
12. Rocuzzo M, De Angelis N, Bonino L, Aglietta M. Ten-year results of a three-arm prospective cohort study on implants in periodontally compromised patients. Part 1: implant loss and radiographic bone loss. *Clin Oral Implants Res*. 2010;21:490-496. doi: 10.1111/j.1600-0501.2009.01886.x. Epub 2010 Mar 11. PMID: 20337668.
13. Dohan Ehrenfest DM, Coelho PG, Kang BS, Sul YT, Albrektsson T. Classification of osseointegrated implant surfaces: materials, chemistry and topography. *Trends Biotechnol*. 2010;28:198-206. doi: 10.1038/tbt.2010.111

- 10.1016/j.tibtech.2009.12.003. Epub 2010 Jan 29. PMID: 20116873.
14. Fischer K, Stenberg T. Prospective 10-year cohort study based on a randomized controlled trial (RCT) on implant-supported full-arch maxillary prostheses. Part 1: sandblasted and acid-etched implants and mucosal tissue. *Clin Implant Dent Relat Res*. 2012;14:808-815. doi: 10.1111/j.1708-8208.2011.00389.x. Epub 2011 Oct 18. PMID: 22008715.
 15. Roccuzzo M, Bonino F, Aglietta M, Dalmasso P. Ten-year results of a three arms prospective cohort study on implants in periodontally compromised patients. Part 2: clinical results. *Clin Oral Implants Res*. 2012;23:389-395. doi: 10.1111/j.1600-0501.2011.02309.x. Epub 2011 Sep 28. PMID: 22092445.
 16. Larsson Wexell C, Thomsen P, Aronsson BO, et al. Bone response to surface-modified titanium implants: studies on the early tissue response to implants with different surface characteristics. *Int J Biomater*. 2013;2013:412482. doi: 10.1155/2013/412482. Epub 2013 Sep 23. PMID: 24174936; PMCID: PMC3794548.
 17. Roccuzzo M, Bonino L, Dalmasso P, Aglietta M. Long-term results of a three arms prospective cohort study on implants in periodontally compromised patients: 10-year data around sandblasted and acid-etched (SLA) surface. *Clin Oral Implants Res*. 2014;25:1105-1112. doi: 10.1111/clr.12227. Epub 2013 Jul 19. PMID: 23865554.
 18. von Wilmowsky C, Moest T, Nkenke E, Stelzle F, Schlegel KA. Implants in bone: part I. A current overview about tissue response, surface modifications and future perspectives. *Oral Maxillofac Surg*. 2014;18:243-257. doi: 10.1007/s10006-013-0398-1. Epub 2013 Feb 24. PMID: 23435578.
 19. Namgoong H, Kim MD, Ku Y, et al. Bone reconstruction after surgical treatment of experimental peri-implantitis defects at a sandblasted/acid-etched hydroxyapatite-coated implant: an experimental study in the dog. *J Clin Periodontol*. 2015;42:960-966. doi: 10.1111/jcpe.12457. Epub 2015 Oct 15. PMID: 26362968.
 20. Glauser R. Implants with an Oxidized Surface Placed Predominately in Soft Bone Quality and Subjected to Immediate Occlusal Loading: Results from an 11-Year Clinical Follow-Up. *Clin Implant Dent Relat Res*. 2016;18:429-438. doi: 10.1111/cid.12327. Epub 2015 Aug 13. PMID: 26268951.
 21. Chrcanovic BR, Kisich J, Albrektsson T, Wennerberg A. Factors Influencing Early Dental Implant Failures. *J Dent Res*. 2016;95:995-1002. doi: 10.1177/0022034516646098. Epub 2016 May 4. PMID: 27146701.
 22. Roccuzzo M, Pittoni D, Roccuzzo A, Charrier L, Dalmasso P. Surgical treatment of peri-implantitis intrabony lesions by means of deproteinized bovine bone mineral with 10% collagen: 7-year-results. *Clin Oral Implants Res*. 2017;28:1577-1583. doi: 10.1111/clr.13028. Epub 2017 Jun 18. PMID: 28626970.
 23. Wennerberg A, Albrektsson T, Chrcanovic B. Long-term clinical outcome of implants with different surface modifications. *Eur J Oral Implantol*. 2018;11 Suppl 1:S123-S136. PMID: 30109304.
 24. Bermejo P, Sánchez MC, Llama-Palacios A, Figuero E, Herrera D, Sanz Alonso M. Biofilm formation on dental implants with different surface micro-topography: An in vitro study. *Clin Oral Implants Res*. 2019;30:725-734. doi: 10.1111/clr.13455. Epub 2019 May 22. PMID: 31077449.

Reviews:

25. Abraham CM. A brief historical perspective on dental implants, their surface coatings and treatments. *Open Dent J*. 2014;8:50-55. doi: 10.2174/1874210601408010050. PMID: 24894638; PMCID: PMC4040928.
26. Cochran DL. A comparison of endosseous dental implant surfaces. *J Periodontol*. 1999 Dec;70(12):1523-39. doi: 10.1902/jop.1999.70.12.1523. PMID: 10632528.
27. De Bruyn H, Christiaens V, Doornewaard R, et al. Implant surface roughness and patient factors on long-term peri-implant bone loss. *Periodontol 2000*. 2017;73:218-227. doi: 10.1111/prd.12177. PMID: 28000269.

Macro-design:

28. Babbush CA, Kirsch A, Mentag PJ, Hill B. Intramobile cylinder (IMZ) two-stage osteointegrated implant system with the intramobile element (IME): part I. Its rationale and procedure for use. *Int J Oral Maxillofac Implants*. 1987;2:203-216.

29. Chong L, Khocht A, Suzuki JB, Gaughan J. Effect of implant design on initial stability of tapered implants. *J Oral Implantol.* 2009;35:130-135.
30. Lee DW, Choi YS, Park KH, Kim CS, Moon IS. Effect of microthread on the maintenance of marginal bone level: a 3-year prospective study. *Clin Oral Implants Res.* 2007;18:465-470.
31. Li T, Kong L, Wang Y, et al. Selection of optimal dental implant diameter and length in type IV bone: a three-dimensional finite element analysis. *Int J Oral Maxillofac Surg.* 2009;38:1077-1083.
32. Morneburg TR, Pröschel PA. Success rates of microimplants in edentulous patients with residual ridge resorption. *Int J Oral Maxillofac Implants.* 2008;23:270-276.

Reviews:

1. Kirsch A, Ackermann KL. The IMZ osteointegrated implant system. *Dent Clin North Am.* 1989;33:733-791.
2. Klein MO, Schiegnitz E, Al-Nawas B. Systematic review on success of narrow-diameter dental implants. *Int J Oral Maxillofac Implants.* 2014;29 Suppl:43-54.

Micro-design:

1. Abrahamsson I, Zitzmann NU, Berglundh T, Wennerberg A, Lindhe J. Bone and soft tissue integration to titanium implants with different surface topography: an experimental study in the dog. *Int J Oral Maxillofac Implants.* 2001;16:323-332.
2. Albouy JP, Abrahamsson I, Persson LG, Berglundh T. Implant surface characteristics influence the outcome of treatment of peri-implantitis: an experimental study in dogs. *J Clin Periodontol.* 2011;38:58-64.
3. Buser D, Schenk RK, Steinemann S, Fiorellini JP, Fox CH, Stich H. Influence of surface characteristics on bone integration of titanium implants. A histomorphometric study in miniature pigs. *J Biomed Mater Res.* 1991;25:889-902.
4. Ellingsen JE, Johansson CB, Wennerberg A, Holmén A. Improved retention and bone-to-implant contact with fluoride-modified titanium implants. *Int J Oral Maxillofac Implants.* 2004;19:659-666.
5. Ivanoff CJ, Hallgren C, Widmark G, Sennerby L, Wennerberg A. Histologic evaluation of the bone integration of TiO(2) blasted and turned titanium microimplants in humans. *Clin Oral Implants Res.* 2001;12:128-134.
6. Khang W, Feldman S, Hawley CE, Gunsolley J. A multi-center study comparing dual acid-etched and machined-surfaced implants in various bone qualities. *J Periodontol.* 2001;72:1384-1390.
7. Klokkevold PR, Johnson P, Dadgostari S, Caputo A, Davies JE, Nishimura RD. Early endosseous integration enhanced by dual acid etching of titanium: a torque removal study in the rabbit. *Clin Oral Implants Res.* 2001;12:350-357.
8. Krauser JT. Hydroxylapatite-coated dental implants. Biologic rationale and surgical technique. *Dent Clin North Am.* 1989;33:879-903.
9. Lang NP, Salvi GE, Huynh-Ba G, Ivanovski S, Donos N, Bosshardt DD. Early osseointegration to hydrophilic and hydrophobic implant surfaces in humans. *Clin Oral Implants Res.* 2011;22:349-356.
10. Lazzara RJ, Testori T, Trisi P, Porter SS, Weinstein RL. A human histologic analysis of osseotite and machined surfaces using implants with 2 opposing surfaces. *Int J Periodontics Restorative Dent.* 1999;19:117-129.
11. Orsini G, Assenza B, Scarano A, Piattelli M, Piattelli A. Surface analysis of machined versus sandblasted and acid-etched titanium implants. *Int J Oral Maxillofac Implants.* 2000;15:779-784.
12. Schwarz F, Ferrari D, Herten M, et al. Effects of surface hydrophilicity and microtopography on early stages of soft and hard tissue integration at non-submerged titanium implants: an immunohistochemical study in dogs. *J Periodontol.* 2007;78:2171-2184.
13. Stach RM, Kohles SS. A meta-analysis examining the clinical survivability of machined-surfaced and osseotite implants in poor-quality bone. *Implant Dent.* 2003;12:87-96.
14. Sul YT, Johansson C, Wennerberg A, Cho LR, Chang BS, Albrektsson T. Optimum surface properties of dental implants. *Int J Oral Maxillofac Implants.* 2004;19:108-115.

oxidized implants for reinforcement of osseointegration: surface chemistry, oxide thickness, porosity, roughness, and crystal structure. *Int J Oral Maxillofac Implants*. 2005;20:349-359.

15. Wennerberg A, Albrektsson T, Chrcanovic B. Long-term clinical outcome of implants with different surface modifications. *Eur J Oral Implantol*. 2018;11 Suppl 1:S123-S136.

Reviews:

1. Biesbroek AR, Edgerton M. Evaluation of the clinical predictability of hydroxyapatite-coated endosseous dental implants: a review of the literature. *Int J Oral Maxillofac Implants*. 1995;10:712-720.
2. Cochran DL. A comparison of endosseous dental implant surfaces. *J Periodontol*. 1999;70:1523-1539.
3. De Bruyn H, Christiaens V, Doornewaard R, et al. Implant surface roughness and patient factors on long-term peri-implant bone loss. *Periodontol 2000*. 2017;73:218-227.
4. Abraham CM. A brief historical perspective on dental implants, their surface coatings and treatments. *Open Dent J*. 2014;8:50-55. DOI: 10.2174/1874210601408010050

19.10 *Implant-tooth-supported fixed partial denture*

1. Ericsson I, Lekholm U, Bränemark PI, Lindhe J, Glantz PO, Nyman S. A clinical evaluation of fixed-bridge restorations supported by the combination of teeth and osseointegrated titanium implants. *J Clin Periodontol* 1986;13:307-312. doi: 10.1111/j.1600-051x.1986.tb02227.x. PMID: 3519692.
2. van Steenberghe D. A retrospective multicenter evaluation of the survival rate of osseointegrated fixtures supporting fixed partial prostheses in the treatment of partial edentulism. *J Prosthet Dent* 1989;61:217-223. doi: 10.1016/0022-3913(89)90378-8. PMID: 2654366
3. Astrand P, Borg K, Gunne J, Olsson M. Combination of natural teeth and osseointegrated implants as prosthesis abutments: a 2-year longitudinal study. *Int J Oral Maxillofac Implants* 1991;6:305-312. PMID: 1813398
4. Rangert B, Gunne J, Sullivan DY. Mechanical aspects of a Bränemark implant connected to a natural tooth: an in vitro study. *Int J Oral Maxillofac Implants* 1991;6:177-186. PMID: 1809673
5. Gunne J, Astrand P, Ahlén K, Borg K, Olsson M. Implants in partially edentulous patients. A longitudinal study of bridges supported by both implants and natural teeth. *Clin Oral Implants Res* 1992;3:49-56. doi: 10.1034/j.1600-0501.1992.030201.x. PMID: 15900668
6. Kay HB. Free-standing versus implant-tooth-interconnected restorations: understanding the prosthodontic perspective. *Int J Periodontics Restorative Dent* 1993;13:47-69. PMID: 8330946
7. Breeding LC, Dixon DL, Sadler JP, McKay ML. Mechanical considerations for the implant tooth-supported fixed partial denture. *J Prosthet Dent* 1995;74:487-492 doi: 10.1016/s0022-3913(05)80350-6. PMID: 8809254.
8. Olsson M, Gunne J, Astrand P, Borg K. Bridges supported by free-standing implants versus bridges supported by tooth and implant. A five-year prospective study. *Clin Oral Implants Res* 1995;6:114-121doi: 10.1034/j.1600-0501.1995.060207.x. PMID: 7578781.
9. Gross M, Laufer BZ. Splinting osseointegrated implants and natural teeth in rehabilitation of partially edentulous patients. Part I: laboratory and clinical studies. *J Oral Rehabil* 1997;24:863-870 doi: 10.1046/j.1365-2842.1997.00582.x. PMID: 9426169.
10. Laufer BZ, Gross M. Splinting osseointegrated implants and natural teeth in rehabilitation of partially edentulous patients. Part II: principles and applications. *J Oral Rehabil* 1998;25:69-80. doi: 10.1046/j.1365-2842.1998.00583.x. PMID: 9502130..
11. Chee WW. Provisional restorations in soft tissue management around dental implants. *Periodontol 2000* 2001;27:139-147. doi: 10.1034/j.1600-0757.2001.027001139.x. PMID: 11551305.
12. Bragger U, Karoussis I, Persson R, Pjetursson B, Salvi G, Lang N. Technical and biological complications/failures with single crowns and fixed partial dentures on implants: a 10-year prospective cohort study. *Clin Oral Implants Res* 2005;16:326-334. doi: 10.1111/j.1600-0501.2005.01105.x. PMID: 15877753.

13. Eliasson A, Eriksson T, Johansson A, Wennerberg A. Fixed partial prostheses supported by 2 or 3 implants: a retrospective study up to 18 years. *Int J Oral Maxillofac Implants* 2006;21:567-574. PMID: 16955607
14. Torabinejad M, Anderson P, Bader J, et al. Outcomes of root canal treatment and restoration, implant-supported single crowns, fixed partial dentures, and extraction without replacement: a systematic review. *J Prosthet Dent* 2007;98:285-311. doi: 10.1016/S0022-3913(07)60102-4. PMID: 17936128.
15. Salinas TJ, Eckert SE. In patients requiring single-tooth replacement, what are the outcomes of implant-as compared to tooth-supported restorations? *Int J Oral Maxillofac Implants* 2007;22 Suppl:71-95. PMID: 18437792
16. Greenstein G, Cavallaro J, Smith R, Tarnow D. Connecting teeth to implants: a critical review of the literature and presentation of practical guidelines. *Compend Contin Educ Dent* 2009;30:440-453. PMID: 19757737
17. Wilson TG, Jr. The positive relationship between excess cement and peri-implant disease: a prospective clinical endoscopic study. *J Periodontol* 2009;80:1388-1392. doi: 10.1902/jop.2009.090115. PMID: 19722787.
18. Pieri F, Aldini NN, Marchetti C, Corinaldesi G. Influence of implant-abutment interface design on bone and soft tissue levels around immediately placed and restored single-tooth implants: a randomized controlled clinical trial. *Int J Oral Maxillofac Implants* 2011;26:169-178. PMID: 21365053
19. Papaspyridakos P, Chen CJ, Chuang SK, Weber HP, Gallucci GO. A systematic review of biologic and technical complications with fixed implant rehabilitations for edentulous patients. *Int J Oral Maxillofac Implants* 2012;27:102-110. PMID: 22299086
20. Emami E, Michaud PL, Sallaleh I, Feine JS. Implant-assisted complete prostheses. *Periodontol 2000* 2014;66:119-131. doi: 10.1111/prd.12041. PMID: 25123765.
21. Kim P, Ivanovski S, Latcham N, Mattheos N. The impact of cantilevers on biological and technical success outcomes of implant-supported fixed partial dentures. A retrospective cohort study. *Clin Oral Implants Res* 2014;25:175-184. doi: 10.1111/cor.12102. Epub 2013 Jan 2. PMID: 23281736.
22. Zancope K, Simamoto Junior PC, Davi LR, Prado CJ, Neves FD. Immediate loading implants with mandibular overdenture: a 48-month prospective follow-up study. *Braz Oral Res* 2014;28. doi: 10.1590/1807-3107bor-2014.vol28.0030. Epub 2014 Aug 18. PMID: 25141015.
23. Walton TR. An Up-to-15-Year Comparison of the Survival and Complication Burden of Three-Unit Tooth-Supported Fixed Dental Prostheses and Implant-Supported Single Crowns. *Int J Oral Maxillofac Implants* 2015;30:851-861. doi: 10.11607/jomi.4220. PMID: 26252025.
24. Katafuchi M, Weinstein BF, Leroux BG, Chen YW, Daubert DM. Restoration contour is a risk indicator for peri-implantitis: A cross-sectional radiographic analysis. *J Clin Periodontol* 2018;45:225-232. doi: 10.1111/jcpe.12829. Epub 2017 Dec 5. PMID: 28985447.
25. Ravida A, Tattan M, Askar H, Barootchi S, Tavelli L, Wang HL. Comparison of three different types of implant-supported fixed dental prostheses: A long-term retrospective study of clinical outcomes and cost-effectiveness. *Clin Oral Implants Res* 2019;30:295-305. doi: 10.1111/cor.13415. Epub 2019 Mar 29. PMID: 30758878.
26. Koutouzis T. Implant-abutment connection as contributing factor to peri-implant diseases. *Periodontol 2000* 2019;81:152-166. doi: 10.1111/prd.12289. PMID: 31407436.
27. Dixon DR, London RM. Restorative design and associated risks for peri-implant diseases. *Periodontol 2000* 2019;81:167-178. doi: 10.1111/prd.12290. PMID: 31407441.
28. Liang CH, Nien CY, Chen YL, Hsu KW. The prevalence and associated factors of proximal contact loss between implant restoration and adjacent tooth after function: A retrospective study. *Clin Implant Dent Relat Res* 2020;22:351-358. doi: 10.1111/cid.12918. Epub 2020 May 17. PMID: 32419242.
29. Duong HY, Roccuzzo A, Stähli A, Salvi GE, Lang NP, Sculean A. Oral health-related quality of life of patients rehabilitated with fixed and removable implant-supported dental prostheses. *Periodontol 2000* 2022;88:201-237. doi: 10.1111/prd.12419. PMID: 35103325; PMCID: PMC9304161.

30. Lang NP, Pjetursson BE, Tan K, Bragger U, Egger M, Zwahlen M. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years. II. Combined tooth--implant-supported FPDs. *Clin Oral Implants Res* 2004;15:643-653doi: 10.1111/j.1600-0501.2004.01118.x.PMID: 15533125
31. Chee WW, Mordohai N. Tooth-to-implant connection: a systematic review of the literature and a case report utilizing a new connection design. *Clin Implant Dent Relat Res* 2010;12:122-133. doi: 10.1111/j.1708-8208.2008.00144.x. Epub 2009 Feb 13. PMID: 19220844.
32. Monje A, Chan HL, Suarez F, Galindo-Moreno P, Wang HL. Marginal bone loss around tilted implants in comparison to straight implants: a meta-analysis. *Int J Oral Maxillofac Implants* 2012;27:1576-1583. PMID: 23189313
33. Garaicoa-Pazmino C, Suarez-Lopez del Amo F, Monje A, et al. Influence of crown/implant ratio on marginal bone loss: a systematic review. *J Periodontol* 2014;85:1214-1221. doi: 10.1902/jop.2014.130615. Epub 2014 Jan 20. PMID: 24444399.
34. Wittneben JG, Millen C, Brägger U. Clinical performance of screw- versus cement-retained fixed implant-supported reconstructions--a systematic review. *Int J Oral Maxillofac Implants* 2014;29 Suppl:84-98. doi: 10.11607/jomi.2014suppl.g2.1. PMID: 24660192.
35. Sailer I, Karasan D, Todorovic A, Ligoutsikou M, Pjetursson BE. Prosthetic failures in dental implant therapy. *Periodontol 2000* 2022;88:130-144. doi: 10.1111/prd.12416. PMID: 35103329; PMCID: PMC9305548.
36. Carra MC, Range H, Swerts PJ, Tuand K, Vandamme K, Bouchard P. Effectiveness of implant-supported fixed partial denture in patients with history of periodontitis: A systematic review and meta-analysis. *J Clin Periodontol* 2022;49 Suppl 24:208-223. doi: 10.1111/jcpe.13481. Epub 2021 Nov 14. PMID: 34775625.
37. Ramanauskaite A, Becker K, Wolfart S, Lukman F, Schwarz F. Efficacy of rehabilitation with different approaches of implant-supported full-arch prosthetic designs: A systematic review. *J Clin Periodontol* 2022;49 Suppl 24:272-290. doi: 10.1111/jcpe.13540. Epub 2021 Nov 10. PMID: 34761399.

19.11 Short Implants

1. Lum LB. A biomechanical rationale for the use of short implants. *J Oral Implantol* 1991;17:126-131. PMID: 1811063
2. ten Bruggenkate CM, Asikainen P, Foitzik C, Krekeler G, Sutter F. Short (6-mm) nonsubmerged dental implants: results of a Multicenter clinical trial of 1 to 7 years. *Int J Oral Maxillofac Implants* 1998;13:791-798. PMID: 9857589
3. Davarpanah M, Martinez H, Tecucianu JF, Celletti R, Lazzara R. Small-diameter implants: indications and contraindications. *J Esthet Dent* 2000;12:186-194. doi: 10.1111/j.1708-8240.2000.tb00221.x.
4. Vigolo P, Givani A. Clinical evaluation of single-tooth mini-implant restorations: a five-year retrospective study. *J Prosthet Dent* 2000;84:50-54. doi: 10.1067/mpd.2000.107674.
5. Andersen E, Saxegaard E, Knutsen BM, Haanaes HR. A prospective clinical study evaluating the safety and effectiveness of narrow-diameter threaded implants in the anterior region of the maxilla. *Int J Oral Maxillofac Implants* 2001;16:217-224. PMID: 11324210
6. Deporter D, Pilliar RM, Todescan R, Watson P, Pharoah M. Managing the posterior mandible of partially edentulous patients with short, porous-surfaced dental implants: early data from a clinical trial. *Int J Oral Maxillofac Implants* 2001;16:653-658. PMID: 11669247
7. Tawil G, Younan R. Clinical evaluation of short, machined-surface implants followed for 12 to 92 months. *Int J Oral Maxillofac Implants* 2003;18:894-901. PMID: 14696666
8. Chiapasco M. Early and immediate restoration and loading of implants in completely edentulous patients. *Int J Oral Maxillofac Implants* 2004;19 Suppl:76-91. PMID: 15635948
9. Feldman S, Boitel N, Weng D, Kohles SS, Stach RM. Five-year survival distributions of short-length (10 mm or less) machined-surfaced and Osseotite implants. *Clin Implant Dent Relat Res* 2004;6:16-23. doi: 10.1111/j.1708-8208.2004.tb00023.x.
10. Griffin TJ, Cheung WS. The use of short, wide implants in posterior areas with reduced bone height:¹⁴⁶ retrospective investigation. *J Prosthet Dent* 2004;92:139-144. doi: 10.1016/j.jprostdent.2004.05.010.

11. Romeo E, Lops D, Margutti E, Ghisolfi M, Chiapasco M, Vogel G. Long-term survival and success of oral implants in the treatment of full and partial arches: a 7-year prospective study with the ITI dental implant system. *Int J Oral Maxillofac Implants* 2004;19:247-259. PMID: 15101597
12. Vigolo P, Givani A, Majzoub Z, Cordioli G. Clinical evaluation of small-diameter implants in single-tooth and multiple-implant restorations: a 7-year retrospective study. *Int J Oral Maxillofac Implants* 2004;19:703-709. PMID: 15508986
13. Zinsli B, Sägesser T, Mericske E, Mericske-Stern R. Clinical evaluation of small-diameter ITI implants: a prospective study. *Int J Oral Maxillofac Implants* 2004;19:92-99. PMID: 14982361
14. Feldman S, Boitel N, Weng D, Kohles SS, Stach RM. Five-year survival distributions of short-length (10 mm or less) machined-surfaced and Osseotite implants. *Clin Implant Dent Relat Res* 2004;6:16-23. doi: 10.1111/j.1708-8208.2004.tb00023.x.
15. Anner R, Better H, Chaushu G. The clinical effectiveness of 6 mm diameter implants. *J Periodontol* 2005;76:1013-1015. doi: 10.1902/jop.2005.76.6.1013.
16. Comfort MB, Chu FC, Chai J, Wat PY, Chow TW. A 5-year prospective study on small diameter screw-shaped oral implants. *J Oral Rehabil* 2005;32:341-345 doi: 10.1111/j.1365-2842.2004.01441.x.
17. Goene R, Bianchesi C, Huerzeler M, et al. Performance of short implants in partial restorations: 3-year follow-up of Osseotite implants. *Implant Dent* 2005;14:274-280. doi: 10.1097/01.id.0000173335.90854.d8.
18. Misch CE, Steignga J, Barboza E, Misch-Dietsh F, Cianciola LJ, Kazor C. Short dental implants in posterior partial edentulism: a multicenter retrospective 6-year case series study. *J Periodontol* 2006;77:1340-1347. doi: 10.1902/jop.2006.050402.
19. Renouard F, Nisand D. Impact of implant length and diameter on survival rates. *Clin Oral Implants Res* 2006;17 Suppl 2:35-51. doi: 10.1111/j.1600-0501.2006.01349.x.
20. Renouard F, Nisand D. Short implants in the severely resorbed maxilla: a 2-year retrospective clinical study. *Clin Implant Dent Relat Res* 2005;7 Suppl 1:S104-110. doi: 10.1111/j.1708-8208.2005.tb00082.x.
21. Malo P, de Araujo Nobre M, Rangert B. Short implants placed one-stage in maxillae and mandibles: a retrospective clinical study with 1 to 9 years of follow-up. *Clin Implant Dent Relat Res* 2007;9:15-21. doi: 10.1111/j.1708-8208.2006.00027.x.
22. Degidi M, Piattelli A, Carinci F. Clinical outcome of narrow diameter implants: a retrospective study of 510 implants. *J Periodontol* 2008;79:49-54. doi: 10.1902/jop.2008.070248.
23. Fugazzotto PA. Shorter implants in clinical practice: rationale and treatment results. *Int J Oral Maxillofac Implants* 2008;23:487-496. PMID: 18700373
24. Grant BT, Pancko FX, Kraut RA. Outcomes of placing short dental implants in the posterior mandible: a retrospective study of 124 cases. *J Oral Maxillofac Surg* 2009;67:713-717. doi: 10.1016/j.joms.2008.11.004.
25. Anitua E, Orive G. Short implants in maxillae and mandibles: a retrospective study with 1 to 8 years of follow-up. *J Periodontol* 2010;81:819-826. doi: 10.1902/jop.2010.090637.
26. Rossi F, Ricci E, Marchetti C, Lang NP, Botticelli D. Early loading of single crowns supported by 6-mm-long implants with a moderately rough surface: a prospective 2-year follow-up cohort study. *Clin Oral Implants Res* 2010;21:937-943. doi: 10.1111/j.1600-0501.2010.01942.x.
27. Anitua E, Pinas L, Begona L, Orive G. Long-term retrospective evaluation of short implants in the posterior areas: clinical results after 10-12 years. *J Clin Periodontol* 2014;41:404-411. doi: 10.1111/jcpe.12222.
28. Esposito M, Pistilli R, Barausse C, Felice P. Three-year results from a randomised controlled trial comparing prostheses supported by 5-mm long implants or by longer implants in augmented bone in posterior atrophic edentulous jaws. *Eur J Oral Implantol* 2014;7:383-395. PMID: 25422826
29. Nisand D, Renouard F. Short implant in limited bone volume. *Periodontology 2000* 2014;66:72-96. doi: 10.1111/prd.12053.
30. Schincaglia GP, Thoma DS, Haas R, et al. Randomized controlled multicenter study comparing short dental implants (6 mm) versus longer dental implants (11-15 mm) in combination with sinus floor elevation procedures. Part 2: clinical and radiographic outcomes at 1 year of loading. *J Clin Periodontol* 2015;42:1042-1051. doi: 10.1111/jcpe.12465.

31. Guljé FL, Raghoobar GM, Erkens WA, Meijer HJ. Impact of Crown-Implant Ratio of Single Restorations Supported by 6-mm Implants: A Short-Term Case Series Study. *Int J Oral Maxillofac Implants* 2016;31:672-675. doi: 10.11607/jomi.4092.
32. Rossi F, Botticelli D, Cesaretti G, De Santis E, Storelli S, Lang NP. Use of short implants (6 mm) in a single-tooth replacement: a 5-year follow-up prospective randomized controlled multicenter clinical study. *Clin Oral Implants Res* 2016;27:458-464. doi: 10.1111/clr.12564.
33. Pohl V, Thoma DS, Sporniak-Tutak K, et al. Short dental implants (6 mm) versus long dental implants (11-15 mm) in combination with sinus floor elevation procedures: 3-year results from a multicentre, randomized, controlled clinical trial. *J Clin Periodontol* 2017;44:438-445. doi: 10.1111/jcpe.12694.
34. Jung RE, Al-Nawas B, Araujo M, et al. Group 1 ITI Consensus Report: The influence of implant length and design and medications on clinical and patient-reported outcomes. *Clin Oral Implants Res* 2018;29 Suppl 16:69-77. doi: 10.1111/clr.13342.

Review:

1. Ravida A, Wang IC, Barootchi S, et al. Meta-analysis of randomized clinical trials comparing clinical and patient-reported outcomes between extra-short (</=6 mm) and longer (>/=10 mm) implants. *J Clin Periodontol* 2019;46:118-142. doi: 10.1111/jcpe.13026.
2. Misch CE. Short dental implants: a literature review and rationale for use. *Dent Today* 2005;24:64-66, 68. PMID: 16161821
3. Annibali S, Cristalli MP, Dell'Aquila D, Bignozzi I, La Monaca G, Pilloni A. Short dental implants: a systematic review. *J Dent Res* 2012;91:25-32. doi: 10.1177/0022034511425675.
4. Deporter D. Short dental implants: what works and what doesn't? A literature interpretation. *Int J Periodontics Restorative Dent* 2013;33:457-464. doi: 10.11607/prd.1304.
5. Monje A, Chan HL, Fu JH, Suarez F, Galindo-Moreno P, Wang HL. Are short dental implants (<10 mm) effective? a meta-analysis on prospective clinical trials. *J Periodontol* 2013;84:895-904. doi: 10.1902/jop.2012.120328.
6. Papaspyridakos P, De Souza A, Vazouras K, Gholami H, Pagni S, Weber HP. Survival rates of short dental implants (</=6 mm) compared with implants longer than 6 mm in posterior jaw areas: A meta-analysis. *Clin Oral Implants Res* 2018;29 Suppl 16:8-20. doi: 10.1111/clr.13289.
7. Pommer B, Mailath-Pokorny G, Haas R, Buseniechner D, Millesi W, Fürhauser R. Extra-short (< 7 mm) and extra-narrow diameter (< 3.5 mm) implants: a meta-analytic literature review. *Eur J Oral Implantol* 2018;11 Suppl 1:S137-s146. PMID: 30109305
8. Bitaraf T, Keshtkar A, Rokn AR, Monzavi A, Geramy A, Hashemi K. Comparing short dental implant and standard dental implant in terms of marginal bone level changes: A systematic review and meta-analysis of randomized controlled trials. *Clin Implant Dent Relat Res* 2019;21:796-812. doi: 10.1111/cid.12774.
9. Nielsen HB, Schou S, Isidor F, Christensen AE, Starch-Jensen T. Short implants (</=8mm) compared to standard length implants (>8mm) in conjunction with maxillary sinus floor augmentation: a systematic review and meta-analysis. *Int J Oral Maxillofac Surg* 2019;48:239-249. doi: 10.1016/j.ijom.2018.05.010.

19.12 Zirconia Implants

1. Borgonovo AE, Censi R, Vavassori V, et al. Evaluation of the success criteria for zirconia dental implants: a four-year clinical and radiological study. *Int J Dent* 2013;2013:463073. doi: 10.1155/2013/463073.
2. Brüll F, van Winkelhoff AJ, Cune MS. Zirconia dental implants: a clinical, radiographic, and microbiologic evaluation up to 3 years. *Int J Oral Maxillofac Implants* 2014;29:914-920. doi: 10.11607/jomi.3293.
3. Borgonovo AE, Censi R, Vavassori V, Arnaboldi O, Maiorana C, Re D. Zirconia Implants in Esthetic Areas: 4-Year Follow-Up Evaluation Study. *Int J Dent* 2015;2015:415029. doi: 10.1155/2015/415029.
4. Holländer J, Lorenz J, Stübinger S, et al. Zirconia Dental Implants: Investigation of Clinical Parameters, Patient Satisfaction, and Microbial Contamination. *Int J Oral Maxillofac Implants* 2016;31:855-864. doi: 10.11607/jomi.4511.

5. Kubasiewicz-Ross P, Hadzik J, Dominiak M. Osseointegration of zirconia implants with 3 varying surface textures and a titanium implant: A histological and micro-CT study. *Adv Clin Exp Med* 2018;27:1173-1179. doi: 10.17219/acem/69246.
6. Lorenz J, Giulini N, Holscher W, Schwiertz A, Schwarz F, Sader R. Prospective controlled clinical study investigating long-term clinical parameters, patient satisfaction, and microbial contamination of zirconia implants. *Clin Implant Dent Relat Res* 2019;21:263-271. doi: 10.1111/cid.12720.
7. Wilson NHF, Blum IR. Performance of zirconia implants. *Evid Based Dent* 2019;20:92-93. doi: 10.1038/s41432-019-0046-1.
8. Borgonovo AE, Ferrario S, Maiorana C, Vavassori V, Censi R, Re D. A Clinical and Radiographic Evaluation of Zirconia Dental Implants: 10-Year Follow-Up. *Int J Dent* 2021;2021:7534607. doi: 10.1155/2021/7534607.
9. Bradley H, Owen B, Keys W. Zirconia implants: a promising alternative to titanium? *Evid Based Dent* 2021;22:102-103. doi: 10.1038/s41432-021-0202-2.
10. Aldebes A, Al-Khanati NM, Abou Nassar J, Kharboutly NA, Aldamman F. Effect of restoration material on marginal bone resorption around modified anatomic zirconia dental implants: A randomised controlled trial. *Ann Med Surg (Lond)* 2022;80:104313. doi: 10.1016/j.amsu.2022.104313.
11. Pozzi A, Arcuri L, Fabbri G, Singer G, Londono J. Long-term survival and success of zirconia screw-retained implant-supported prostheses for up to 12 years: A retrospective multicenter study. *J Prosthet Dent* 2023;129:96-108. doi: 10.1016/j.jprosdent.2021.04.026.

Reviews:

12. Hafezeqoran A, Koodaryan R. Effect of Zirconia Dental Implant Surfaces on Bone Integration: A Systematic Review and Meta-Analysis. *Biomed Res Int* 2017;2017:9246721. doi: 10.1155/2017/9246721.
13. Pieralli S, Kohal RJ, Jung RE, Vach K, Spies BC. Clinical Outcomes of Zirconia Dental Implants: A Systematic Review. *J Dent Res* 2017;96:38-46. doi: 10.1177/0022034516664043.
14. Cionca N, Hashim D, Mombelli A. Zirconia dental implants: where are we now, and where are we heading? *Periodontol 2000* 2017;73:241-258. doi: 10.1111/prd.12180.
15. Roehling S, Schlegel KA, Woelfler H, Gahlert M. Performance and outcome of zirconia dental implants in clinical studies: A meta-analysis. *Clin Oral Implants Res* 2018;29 Suppl 16:135-153. doi: 10.1111/clr.13352.
16. Roehling S, Schlegel KA, Woelfler H, Gahlert M. Zirconia compared to titanium dental implants in preclinical studies-A systematic review and meta-analysis. *Clin Oral Implants Res* 2019;30:365-395. doi: 10.1111/clr.13425.

19.13 Guided Implant Surgery

1. Verstreken K, Van Cleynenbreugel J, Marchal G, Naert I, Suetens P, van Steenberghe D. Computer-assisted planning of oral implant surgery: a three-dimensional approach. *Int J Oral Maxillofac Implants* 1996;11:806-810. PMID: 8990645
2. Verstreken K, Van Cleynenbreugel J, Martens K, Marchal G, van Steenberghe D, Suetens P. An image-guided planning system for endosseous oral implants. *IEEE Trans Med Imaging* 1998;17:842-852. doi: 10.1109/42.736056.
3. Jacobs R, Adriansens A, Verstreken K, Suetens P, van Steenberghe D. Predictability of a three-dimensional planning system for oral implant surgery. *Dentomaxillofac Radiol* 1999;28:105-111. doi: 10.1038/sj/dmfr/4600419.
4. Fortin T, Champleboux G, Bianchi S, Buatois H, Coudert JL. Precision of transfer of preoperative planning for oral implants based on cone-beam CT-scan images through a robotic drilling machine. *Clin Oral Implants Res* 2002;13:651-656. doi: 10.1034/j.1600-0501.2002.130612.x.
5. van Steenberghe D, Naert I, Andersson M, Brajnovic I, Van Cleynenbreugel J, Suetens P. A custom template and definitive prosthesis allowing immediate implant loading in the maxilla: a clinical report.¹¹⁹

- Int J Oral Maxillofac Implants 2002;17:663-670.
- 6. Sarment DP, Sukovic P, Clinthorne N. Accuracy of implant placement with a stereolithographic surgical guide. Int J Oral Maxillofac Implants 2003;18:571-577.
 - 7. Di Giacomo GA, Cury PR, de Araujo NS, Sendyk WR, Sendyk CL. Clinical application of stereolithographic surgical guides for implant placement: preliminary results. J Periodontol 2005;76:503-507.
 - 8. Guerrero ME, Jacobs R, Loubele M, Schutyser F, Suetens P, van Steenberghe D. State-of-the-art on cone beam CT imaging for preoperative planning of implant placement. *Clin Oral Investig* 2006;10:1-7. doi: 10.1007/s00784-005-0031-2.
 - 9. Van Assche N, van Steenberghe D, Guerrero ME, et al. Accuracy of implant placement based on pre-surgical planning of three-dimensional cone-beam images: a pilot study. J Clin Periodontol 2007;34:816-821.
 - 10. Ersøy AE, Turkyilmaz I, Ozan O, McGlumphy EA. Reliability of implant placement with stereolithographic surgical guides generated from computed tomography: clinical data from 94 implants. J Periodontol 2008;79:1339-1345.
 - 11. Schneider D, Marquardt P, Zwahlen M, Jung RE. A systematic review on the accuracy and the clinical outcome of computer-guided template-based implant dentistry. *Clin Oral Implants Res* 2009;20 Suppl 4:73-86. doi: 10.1111/j.1600-0501.2009.01788.x.
 - 12. Valente F, Schiroli G, Sbrenna A. Accuracy of computer-aided oral implant surgery: a clinical and radiographic study. *Int J Oral Maxillofac Implants* 2009;24:234-242. PMID: 19492638
 - 13. Ozan O, Turkyilmaz I, Ersøy AE, McGlumphy EA, Rosenstiel SF. Clinical accuracy of 3 different types of computed tomography-derived stereolithographic surgical guides in implant placement. J Oral Maxillofac Surg 2009;67:394-401.
 - 14. Arisan V, Karabuda CZ, Ozdemir T. Implant surgery using bone- and mucosa-supported stereolithographic guides in totally edentulous jaws: surgical and post-operative outcomes of computer-aided vs. standard techniques. *Clin Oral Implants Res* 2010;21:980-988. doi: 10.1111/j.1600-0501.2010.01957.x.
 - 15. Van Assche N, Quirynen M. Tolerance within a surgical guide. *Clin Oral Implants Res* 2010;21:455-458. doi: 10.1111/j.1600-0501.2009.01836.x.
 - 16. Vasak C, Watzak G, Gahleitner A, Strbac G, Schemper M, Zechner W. Computed tomography-based evaluation of template (NobelGuide)-guided implant positions: a prospective radiological study. *Clin Oral Implants Res* 2011;22:1157-1163.
 - 17. Pettersson A, Komiyama A, Hultin M, Nasstrom K, Klinge B. Accuracy of virtually planned and template guided implant surgery on edentate patients. *Clin Implant Dent Relat Res* 2012;14:527-537. doi: 10.1111/j.1708-8208.2010.00285.x.
 - 18. Stumpel LJ. Deformation of stereolithographically produced surgical guides: an observational case series report. *Clin Implant Dent Relat Res* 2012;14:442-453. doi: 10.1111/j.1708-8208.2010.00268.x.
 - 19. Van Assche N, Vercruyssen M, Coucke W, Teughels W, Jacobs R, Quirynen M. Accuracy of computer-aided implant placement. *Clin Oral Implants Res* 2012;23 Suppl 6:112-123. doi: 10.1111/j.1600-0501.2012.02552.x.
 - 20. Cassetta M, Di Mambro A, Giansanti M, Stefanelli LV, Cavallini C. The intrinsic error of a stereolithographic surgical template in implant guided surgery. *Int J Oral Maxillofac Surg* 2013;42:264-275.
 - 21. Arisan V, Karabuda CZ, Mumcu E, Özdemir T. Implant positioning errors in freehand and computer-aided placement methods: a single-blind clinical comparative study. *Int J Oral Maxillofac Implants* 2013;28:190-204. doi: 10.11607/jomi.2691.
 - 22. D'Haese J, De Bruyn H. Effect of smoking habits on accuracy of implant placement using mucosally supported stereolithographic surgical guides. *Clin Implant Dent Relat Res* 2013;15:402-411. doi: 10.1111/j.1708-8208.2011.00353.x.
 - 23. Farley NE, Kennedy K, McGlumphy EA, Clelland NL. Split-mouth comparison of the accuracy of computer-generated and conventional surgical guides. *Int J Oral Maxillofac Implants* 2013;28:563-572. doi: 10.11607/jomi.3025.

24. Stumpel LJ. Congruency of stereo lithographically produced surgical guide bases made from the same CBCT file: a pilot study. *Clin Implant Dent Relat Res* 2013;15:531-537. doi: 10.1111/j.1708-8208.2012.00443.x.
25. Jacobs R, Quirynen M. Dental cone beam computed tomography: justification for use in planning oral implant placement. *Periodontol 2000* 2014;66:203-213. doi: 10.1111/prd.12051.
26. Noharet R, Pettersson A, Bourgeois D. Accuracy of implant placement in the posterior maxilla as related to 2 types of surgical guides: a pilot study in the human cadaver. *J Prosthet Dent* 2014;112:526-532.
27. Schneider D, Schober F, Grohmann P, Hammerle CH, Jung RE. In-vitro evaluation of the tolerance of surgical instruments in templates for computer-assisted guided implantology produced by 3-D printing. *Clin Oral Implants Res* 2015;26:320-325. doi: 10.1111/clr.12327.
28. Sun Y, Luebbers HT, Agbaje JO, et al. Accuracy of Dental Implant Placement Using CBCT-Derived Mucosa-Supported Stereolithographic Template. *Clin Implant Dent Relat Res* 2015;17:862-870. doi: 10.1111/cid.12189.
29. Verhamme LM, Meijer GJ, Boumans T, de Haan AF, Berge SJ, Maal TJ. A clinically relevant accuracy study of computer-planned implant placement in the edentulous maxilla using mucosa-supported surgical templates. *Clin Implant Dent Relat Res* 2015;17:343-352.
30. Vercruyssen M, Cox C, Coucke W, Naert I, Jacobs R, Quirynen M. A randomized clinical trial comparing guided implant surgery (bone- or mucosa-supported) with mental navigation or the use of a pilot-drill template. *J Clin Periodontol* 2014;41:717-723.
31. Vercruyssen M, Coucke W, Naert I, Jacobs R, Teughels W, Quirynen M. Depth and lateral deviations in guided implant surgery: an RCT comparing guided surgery with mental navigation or the use of a pilot-drill template. *Clin Oral Implants Res* 2015;26:1315-1320. doi: 10.1111/clr.12460.
32. Van de Wiele G, Teughels W, Vercruyssen M, Coucke W, Temmerman A, Quirynen M. The accuracy of guided surgery via mucosa-supported stereolithographic surgical templates in the hands of surgeons with little experience. *Clin Oral Implants Res* 2015;26:1489-1494.
33. Furhauser R, Mailath-Pokorny G, Haas R, Busenlechner D, Watzek G, Pommer B. Esthetics of Flapless Single-Tooth Implants in the Anterior Maxilla Using Guided Surgery: Association of Three-Dimensional Accuracy and Pink Esthetic Score. *Clin Implant Dent Relat Res* 2015;17 Suppl 2:e427-433.
34. Flugge T, Derkens W, Te Poel J, Hassan B, Nelson K, Wismeijer D. Registration of cone beam computed tomography data and intraoral surface scans - A prerequisite for guided implant surgery with CAD/CAM drilling guides. *Clin Oral Implants Res* 2017;28:1113-1118.
35. Kim JE, Amelya A, Shin Y, Shim JS. Accuracy of intraoral digital impressions using an artificial landmark. *J Prosthet Dent* 2017;117:755-761.
36. Smitkarn P, Subbalekha K, Mattheos N, Pimkhaokham A. The accuracy of single-tooth implants placed using fully digital-guided surgery and freehand implant surgery. *J Clin Periodontol* 2019;46:949-957.
37. Kaewsiri D, Panmekiate S, Subbalekha K, Mattheos N, Pimkhaokham A. The accuracy of static vs. dynamic computer-assisted implant surgery in single tooth space: A randomized controlled trial. *Clin Oral Implants Res* 2019;30:505-514.
38. Magrin GL, Rafael SNF, Passoni BB, et al. Clinical and tomographic comparison of dental implants placed by guided virtual surgery versus conventional technique: A split-mouth randomized clinical trial. *J Clin Periodontol* 2020;47:120-128.

Review

39. Hultin M, Svensson KG, Trulsson M. Clinical advantages of computer-guided implant placement: a systematic review. *Clin Oral Implants Res* 2012;23 Suppl 6:124-135. doi: 10.1111/j.1600-0501.2012.02545.x.
40. Tahmaseb A, Wismeijer D, Coucke W, Derkens W. Computer technology applications in surgical implant dentistry: a systematic review. *Int J Oral Maxillofac Implants* 2014;29 Suppl:25-42. doi: 10.11607/jomi.2014suppl.g1.2.
41. Vercruyssen M, Fortin T, Widmann G, Jacobs R, Quirynen M. Different techniques of static/dynamic guided implant surgery: modalities and indications. *Periodontol 2000* 2014;66:214-227.

42. Tahmaseb A, Wu V, Wismeijer D, Coucke W, Evans C. The accuracy of static computer-aided implant surgery: A systematic review and meta-analysis. *Clin Oral Implants Res* 2018;29 Suppl 16:416-435.
43. Tatakis DN, Chien HH, Parashis AO. Guided implant surgery risks and their prevention. *Periodontol 2000* 2019;81:194-208.
44. Pellegrino G, Ferri A, Del Fabbro M, Prati C, Gandolfi MG, Marchetti C. Dynamic Navigation in Implant Dentistry: A Systematic Review and Meta-analysis. *Int J Oral Maxillofac Implants* 2021;36:e121-e140.

19.14 Submerged vs. non-submerged approach

Questions to be answered from this section:

- What are the differences in healing of peri-implant tissues between submerged and non-submerged unloaded implants?
- Does one-step (non-submerged) implant placement lead to a higher failure rate and/or a high probability of other complications as compared to two-step approach?

1. Weber HP, Buser D, Donath K, et al. Comparison of healed tissues adjacent to submerged and non-submerged unloaded titanium dental implants. A histometric study in beagle dogs. *Clin Oral Implants Res* 1996;7:11-19.
2. Ericsson I, Nilner K, Klinge B, Glantz PO. Radiographical and histological characteristics of submerged and non-submerged titanium implants. An experimental study in the Labrador dog. *Clin Oral Implants Res* 1996;7:20-26.
3. Hermann JS, Cochran DL, Nummikoski PV, Buser D. Crestal bone changes around titanium implants. A radiographic evaluation of unloaded nonsubmerged and submerged implants in the canine mandible. *J Periodontol* 1997;68:1117-1130.
4. Hermann JS, Buser D, Schenk RK, Cochran DL. Crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged and submerged implants in the canine mandible. *J Periodontol* 2000;71:1412-1424.
5. Ferrigno N, Laureti M, Fanali S, Grippaudo G. A long-term follow-up study of non-submerged ITI implants in the treatment of totally edentulous jaws. Part I: Ten-year life table analysis of a prospective multicenter study with 1286 implants. *Clin Oral Implants Res* 2002;13:260-273.
6. Cecchinato D, Olsson C, Lindhe J. Submerged or non-submerged healing of endosseous implants to be used in the rehabilitation of partially dentate patients. *J Clin Periodontol* 2004;31:299-308.
7. Engquist B, Astrand P, Anzen B, et al. Simplified methods of implant treatment in the edentulous lower jaw: a 3-year follow-up report of a controlled prospective study of one-stage versus two-stage surgery and early loading. *Clin Implant Dent Relat Res* 2005;7:95-104.
8. Cordaro L, Torsello F, Rocuzzo M. Clinical outcome of submerged vs. non-submerged implants placed in fresh extraction sockets. *Clin Oral Implants Res* 2009;20:1307-1313.
9. Sanz M, Ivanoff CJ, Weingart D, et al. Clinical and radiologic outcomes after submerged and transmucosal implant placement with two-piece implants in the anterior maxilla and mandible: 3-year results of a randomized controlled clinical trial. *Clin Implant Dent Relat Res* 2015;17:234-246.
10. Linkevicius T, Puisys A, Linkevicius R, Alkimavicius J, Gineviciute E, Linkeviciene L. The influence of submerged healing abutment or subcrestal implant placement on soft tissue thickness and crestal bone stability. A 2-year randomized clinical trial. *Clin Implant Dent Relat Res* 2020;22:497-506.

Reviews:

1. Chrcanovic BR, Albrektsson T, Wennerberg A. Immediately loaded non-submerged versus delayed loaded submerged dental implants: a meta-analysis. *Int J Oral Maxillofac Surg* 2015;44:493-506.
2. Troiano G, Lo Russo L, Canullo L, Ciavarella D, Lo Muzio L, Laino L. Early and late implant failure of submerged versus non-submerged implant healing: A systematic review, meta-analysis and trial sequential analysis. *J Clin Periodontol* 2018;45:613-623.

19.15 Delayed vs. immediate vs. early placement

Questions to be answered towards the end of this section:

- What are the definitions of immediate, early, and delayed implant placement?
- What are the average soft and hard tissue alterations after immediate implant placement? What are the factors that could influence those alterations?
- What are the critical factors determining the timing of implant placement?
- Are these three implant placement protocols leading to similar long-term outcomes?

Immediate placement

1. Wilson TG, Jr., Schenk R, Buser D, Cochran D. Implants placed in immediate extraction sites: a report of histologic and histometric analyses of human biopsies. *Int J Oral Maxillofac Implants* 1998;13:333-341.
2. Araujo MG, Sukekava F, Wennstrom JL, Lindhe J. Ridge alterations following implant placement in fresh extraction sockets: an experimental study in the dog. *J Clin Periodontol* 2005;32:645-652.
3. Araujo MG, Sukekava F, Wennstrom JL, Lindhe J. Tissue modeling following implant placement in fresh extraction sockets. *Clin Oral Implants Res* 2006;17:615-624.
4. Wagenberg B, Froum SJ. A retrospective study of 1925 consecutively placed immediate implants from 1988 to 2004. *Int J Oral Maxillofac Implants* 2006;21:71-80.
5. Ferrus J, Cecchinato D, Pjetursson EB, Lang NP, Sanz M, Lindhe J. Factors influencing ridge alterations following immediate implant placement into extraction sockets. *Clin Oral Implants Res* 2010;21:22-29.
6. Cooper LF, Reside GJ, Raes F, et al. Immediate provisionalization of dental implants placed in healed alveolar ridges and extraction sockets: a 5-year prospective evaluation. *Int J Oral Maxillofac Implants* 2014;29:709-717.
7. Hita-Iglesias C, Sanchez-Sanchez FJ, Montero J, et al. Immediate Implants Placed in Fresh Sockets Associated with Periapical Pathology: A Split-Mouth Design and Survival Evaluation after 1-Year Follow-Up. *Clin Implant Dent Relat Res* 2016;18:1075-1083.
8. Crespi R, Cappare P, Crespi G, Lo Giudice G, Gastaldi G, Gherlone E. Dental Implants Placed in Periodontally Infected Sites in Humans. *Clin Implant Dent Relat Res* 2017;19:131-139.
9. Tonetti MS, Cortellini P, Graziani F, et al. Immediate versus delayed implant placement after anterior single tooth extraction: the timing randomized controlled clinical trial. *J Clin Periodontol* 2017;44:215-224.
10. Raes S, Eghbali A, Chappuis V, Raes F, De Bruyn H, Cosyn J. A long-term prospective cohort study on immediately restored single tooth implants inserted in extraction sockets and healed ridges: CBCT analyses, soft tissue alterations, aesthetic ratings, and patient-reported outcomes. *Clin Implant Dent Relat Res* 2018;20:522-530.

Early placement

11. Buser D, Chen ST, Weber HP, Belser UC. Early implant placement following single-tooth extraction in the esthetic zone: biologic rationale and surgical procedures. *Int J Periodontics Restorative Dent* 2008;28:441-451.
12. Schropp L, Isidor F. Clinical outcome and patient satisfaction following full-flap elevation for early and delayed placement of single-tooth implants: a 5-year randomized study. *Int J Oral Maxillofac Implants* 2008;23:733-743.
13. Gotfredsen K. A 10-year prospective study of single tooth implants placed in the anterior maxilla. *Clin Implant Dent Relat Res* 2012;14:80-87.
14. Cosyn J, Eghbali A, De Bruyn H, Dierens M, De Rouck T. Single implant treatment in healing versus healed sites of the anterior maxilla: an aesthetic evaluation. *Clin Implant Dent Relat Res* 2012;14:517-526.
15. Buser D, Chappuis V, Bornstein MM, Wittneben JG, Frei M, Belser UC. Long-term stability of contour augmentation with early implant placement following single tooth extraction in the esthetic zone: a prospective, cross-sectional study in 41 patients with a 5- to 9-year follow-up. *J Periodontol* 123

Review:

1. Gallucci GO, Hamilton A, Zhou W, Buser D, Chen S. Implant placement and loading protocols in partially edentulous patients: A systematic review. *Clin Oral Implants Res* 2018;29 Suppl 16:106-134.
2. Tonetti MS, Jung RE, Avila-Ortiz G, et al. Management of the extraction socket and timing of implant placement: Consensus report and clinical recommendations of group 3 of the XV European Workshop in Periodontology. *J Clin Periodontol* 2019;46 Suppl 21:183-194.
3. Cosyn J, De Lat L, Seyssens L, Doornewaard R, Deschepper E, Vervaeke S. The effectiveness of immediate implant placement for single tooth replacement compared to delayed implant placement: A systematic review and meta-analysis. *J Clin Periodontol* 2019;46 Suppl 21:224-241.
4. Bassir SH, El Kholy K, Chen CY, Lee KH, Intini G. Outcome of early dental implant placement versus other dental implant placement protocols: A systematic review and meta-analysis. *J Periodontol* 2019;90:493-506.

19.16 Implant esthetics

Questions to be answered towards the end of this section:

- What are the indices available to evaluate the esthetics of implant-supported single crowns and peri-implant soft tissue?
- What are the factors affecting implant esthetics?

Esthetic indices:

1. Jemt T. Regeneration of gingival papillae after single-implant treatment. *Int J Periodontics Restorative Dent* 1997;17:326-333.
2. Meijer HJ, Stellingsma K, Meijndert L, Raghoebar GM. A new index for rating aesthetics of implant-supported single crowns and adjacent soft tissues--the Implant Crown Aesthetic Index. *Clin Oral Implants Res* 2005;16:645-649.
3. Furhauser R, Florescu D, Benesch T, Haas R, Mailath G, Watzek G. Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. *Clin Oral Implants Res* 2005;16:639-644.
4. Zucchelli G, Barootchi S, Tavelli L, Stefanini M, Rasperini G, Wang HL. Implant soft tissue Dehiscence coverage Esthetic Score (IDES): A pilot within- and between-rater analysis of consistency in objective and subjective scores. *Clin Oral Implants Res* 2021;32:349-358.

Considerations:

1. Belser UC, Buser D, Hess D, Schmid B, Bernard JP, Lang NP. Aesthetic implant restorations in partially edentulous patients--a critical appraisal. *Periodontol 2000* 1998;17:132-150.
2. Chang M, Wennstrom JL, Odman P, Andersson B. Implant supported single-tooth replacements compared to contralateral natural teeth. Crown and soft tissue dimensions. *Clin Oral Implants Res* 1999;10:185-194.
3. Jung RE, Sailer I, Hammerle CH, Attin T, Schmidlin P. In vitro color changes of soft tissues caused by restorative materials. *Int J Periodontics Restorative Dent* 2007;27:251-257.
4. Kan JY, Rungcharassaeng K, Sclar A, Lozada JL. Effects of the facial osseous defect morphology on gingival dynamics after immediate tooth replacement and guided bone regeneration: 1-year results. *J Oral Maxillofac Surg* 2007;65:13-19.
5. Evans CD, Chen ST. Esthetic outcomes of immediate implant placements. *Clin Oral Implants Res* 2008;19:73-80.
6. Belser UC, Grutter L, Vailati F, Bornstein MM, Weber HP, Buser D. Outcome evaluation of early placed maxillary anterior single-tooth implants using objective esthetic criteria: a cross-sectional, retrospective study in 45 patients with a 2- to 4-year follow-up using pink and white esthetic scores. *J Periodontol* 2009;80:140-151.

7. Cosyn J, Eghbali A, Hanselaer L, et al. Four modalities of single implant treatment in the anterior maxilla: a clinical, radiographic, and aesthetic evaluation. *Clin Implant Dent Relat Res* 2013;15:517-530.
8. Esquivel J, Meda RG, Blatz MB. The Impact of 3D Implant Position on Emergence Profile Design. *Int J Periodontics Restorative Dent* 2021;41:79-86.

Reviews:

1. Grunder U, Gracis S, Capelli M. Influence of the 3-D bone-to-implant relationship on esthetics. *Int J Periodontics Restorative Dent* 2005;25:113-119.
2. Fu JH, Lee A, Wang HL. Influence of tissue biotype on implant esthetics. *Int J Oral Maxillofac Implants* 2011;26:499-508.
3. Chen ST, Buser D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla--a systematic review. *Int J Oral Maxillofac Implants* 2014;29 Suppl:186-215.
4. Morton D, Chen ST, Martin WC, Levine RA, Buser D. Consensus statements and recommended clinical procedures regarding optimizing esthetic outcomes in implant dentistry. *Int J Oral Maxillofac Implants* 2014;29 Suppl:216-220.
5. Cosyn J, Thoma DS, Hammerle CH, De Bruyn H. Esthetic assessments in implant dentistry: objective and subjective criteria for clinicians and patients. *Periodontol 2000* 2017;73:193-202.

19.17 Management of completely edentulous patients

Questions to be answered towards the end of this section:

- What are the surgical and restorative options for fully edentulous patients seeking implant therapy?
- What are the long-term outcomes in terms of marginal bone loss and survivals of the implants supporting the full-arch prosthesis?
- What are the surgical considerations for the full-arch rehabilitation by implant therapy?
- How many implants are needed for full-arch fixed prostheses? Does the number of implants play a critical role?

1. Malo P, Rangert B, Nobre M. "All-on-Four" immediate-function concept with Branemark System implants for completely edentulous mandibles: a retrospective clinical study. *Clin Implant Dent Relat Res* 2003;5 Suppl 1:2-9.
2. Capelli M, Zuffetti F, Del Fabbro M, Testori T. Immediate rehabilitation of the completely edentulous jaw with fixed prostheses supported by either upright or tilted implants: a multicenter clinical study. *Int J Oral Maxillofac Implants* 2007;22:639-644.
3. Meijer HJ, Raghoebar GM, Batenburg RH, Visser A, Vissink A. Mandibular overdentures supported by two or four endosseous implants: a 10-year clinical trial. *Clin Oral Implants Res* 2009;20:722-728.
4. Malo P, de Araujo Nobre M, Lopes A, Moss SM, Molina GJ. A longitudinal study of the survival of All-on-4 implants in the mandible with up to 10 years of follow-up. *J Am Dent Assoc* 2011;142:310-320.
5. Slot W, Raghoebar GM, Vissink A, Meijer HJ. Maxillary overdentures supported by four or six implants in the anterior region; 1-year results from a randomized controlled trial. *J Clin Periodontol* 2013;40:303-310.
6. Wang F, Monje A, Huang W, Zhang Z, Wang G, Wu Y. Maxillary Four Implant-retained Overdentures via Locator(R) Attachment: Intermediate-term Results from a Retrospective Study. *Clin Implant Dent Relat Res* 2016;18:571-579.
7. Krennmaier S, Weinlander M, Malek M, Forstner T, Krennmaier G, Stimmelmayr M. Mandibular Full-Arch Fixed Prostheses Supported on 4 Implants with Either Axial Or Tilted Distal Implants: A 3-Year Prospective Study. *Clin Implant Dent Relat Res* 2016;18:1119-1133.
8. Meloni SM, Tallarico M, Pisano M, Xhanari E, Canullo L. Immediate Loading of Fixed Complete Denture Prosthesis Supported by 4-8 Implants Placed Using Guided Surgery: A 5-Year Prospective Study on 66 Patients with 356 Implants. *Clin Implant Dent Relat Res* 2017;19:195-206.
9. Davo R, Felice P, Pistilli R, et al. Immediately loaded zygomatic implants vs conventional dental implants in augmented atrophic maxillae: 1-year post-loading results from a multicentre randomised 125

- controlled trial. *Eur J Oral Implantol* 2018;11:145-161.
10. Carpentieri J, Greenstein G, Cavallaro J. Hierarchy of restorative space required for different types of dental implant prostheses. *J Am Dent Assoc* 2019;150:695-706.

Reviews:

1. Daudt Polido W, Aghaloo T, Emmett TW, Taylor TD, Morton D. Number of implants placed for complete-arch fixed prostheses: A systematic review and meta-analysis. *Clin Oral Implants Res* 2018;29 Suppl 16:154-183.
2. Monje A, Chan HL, Suarez F, Galindo-Moreno P, Wang HL. Marginal bone loss around tilted implants in comparison to straight implants: a meta-analysis. *Int J Oral Maxillofac Implants* 2012;27:1576-1583.

20. Implant Site Development

20.1 Implant Site Evaluation

1. Atwood DA. Reduction of residual ridges: a major oral disease entity. *J Prosthet Dent* 1971;26:266-279.
2. Bornstein MM, Balsiger R, Sendi P, von Arx T. Morphology of the nasopalatine canal and dental implant surgery: a radiographic analysis of 100 consecutive patients using limited cone-beam computed tomography. *Clin Oral Implants Res* 2011;22:295-301.
3. Carlsson GE, Bergman B, Hedegård B. Changes in contour of the maxillary alveolar process under immediate dentures. A longitudinal clinical and x-ray cephalometric study covering 5 years. *Acta Odontol Scand* 1967;25:45-75.
4. Chiapasco M, Romeo E, Vogel G. Vertical distraction osteogenesis of edentulous ridges for improvement of oral implant positioning: a clinical report of preliminary results. *Int J Oral Maxillofac Implants* 2001;16:43-51.
5. Cronin RJ, Oesterle LJ. Implant use in growing patients. Treatment planning concerns. *Dent Clin North Am* 1998;42:1-34.
6. Fudalej P, Kokich VG, Leroux B. Determining the cessation of vertical growth of the craniofacial structures to facilitate placement of single-tooth implants. *Am J Orthod Dentofacial Orthop* 2007;131:S59-67.
7. Greenstein G, Carpentieri JR, Cavallaro J. Nerve damage related to implant dentistry: incidence, diagnosis, and management. *Compend Contin Educ Dent* 2015;36:652-659; quiz 660.
8. Halperin-Sternfeld M, Zigdon-Giladi H, Machtei EE. The association between shallow vestibular depth and peri-implant parameters: a retrospective 6 years longitudinal study. *J Clin Periodontol* 2016;43:305-310.
9. Heij DG, Opdebeeck H, van Steenberghe D, Kokich VG, Belser U, Quirynen M. Facial development, continuous tooth eruption, and mesial drift as compromising factors for implant placement. *Int J Oral Maxillofac Implants* 2006;21:867-878.
10. Kleinheinz J, Büchter A, Kruse-Lösler B, Weingart D, Joos U. Incision design in implant dentistry based on vascularization of the mucosa. *Clin Oral Implants Res* 2005;16:518-523.
11. Mardinger O, Manor Y, Mijiritsky E, Hirshberg A. Lingual perimandibular vessels associated with life-threatening bleeding: an anatomic study. *Int J Oral Maxillofac Implants* 2007;22:127-131.
12. Misch CE, Judy KW. Classification of partially edentulous arches for implant dentistry. *Int J Oral Implantol* 1987;4:7-13.
13. Pietrokovski J, Massler M. Alveolar ridge resorption following tooth extraction. *J Prosthet Dent* 1967;17:21-27.
14. Ritter L, Neugebauer J, Mischkowski RA, et al. Evaluation of the course of the inferior alveolar nerve in the mental foramen by cone beam computed tomography. *Int J Oral Maxillofac Implants* 2012;27:1014-1021.
15. Seibert JS. Reconstruction of deformed, partially edentulous ridges, using full thickness onlay grafts. Part I. Technique and wound healing. *Compend Contin Educ Dent (Lawrenceville)* 1983;4:437-453.
16. Sugerman PB, Barber MT. Patient selection for endosseous dental implants: oral and systemic

- considerations. *Int J Oral Maxillofac Implants* 2002;17:191-201.
17. Tepper G, Hofschneider UB, Gahleitner A, Ulm C. Computed tomographic diagnosis and localization of bone canals in the mandibular interforaminal region for prevention of bleeding complications during implant surgery. *Int J Oral Maxillofac Implants* 2001;16:68-72.
 18. Tinti C, Parma-Benfenati S. Clinical classification of bone defects concerning the placement of dental implants. *Int J Periodontics Restorative Dent* 2003;23:147-155.
 19. Wang HM, Shen JW, Yu MF, Chen XY, Jiang QH, He FM. Analysis of facial bone wall dimensions and sagittal root position in the maxillary esthetic zone: a retrospective study using cone beam computed tomography. *Int J Oral Maxillofac Implants* 2014;29:1123-1129.

Reviews:

1. Jacobs R, Quirynen M, Bornstein MM. Neurovascular disturbances after implant surgery. *Periodontol 2000* 2014;66:188-202.
2. Kalpidis CD, Setayesh RM. Hemorrhaging associated with endosseous implant placement in the anterior mandible: a review of the literature. *J Periodontol* 2004;75:631-645.
3. Lin GH, Chan HL, Wang HL. The significance of keratinized mucosa on implant health: a systematic review. *J Periodontol* 2013;84:1755-1767.

20.1 Alveolar Ridge Preservation

Questions to be answered from this topic:

- Describe the dimensional changes of the ridge following tooth extraction.
- Provide an overview of the histological changes in the healing extraction socket.
- How do dimensional changes differ in sites with socket preservation compared to unassisted socket healing?
- Are there superior materials to be used in alveolar ridge preservation?

Healing after extraction:

1. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. *Int J Periodontics Restorative Dent.* 2003 Aug;23(4):313-23. PMID: 12956475.
2. Cardaropoli G, Araújo M, Lindhe J. Dynamics of bone tissue formation in tooth extraction sites. An experimental study in dogs. *J Clin Periodontol.* 2003 Sep;30(9):809-18. doi: 10.1034/j.1600-051x.2003.00366.x. PMID: 12956657.
3. Ahn JJ, Shin HI. Bone tissue formation in extraction sockets from sites with advanced periodontal disease: a histomorphometric study in humans. *Int J Oral Maxillofac Implants.* 2008 Nov-Dec;23(6):1133-8. PMID: 19216285.
4. Araújo MG, Lindhe J. Ridge alterations following tooth extraction with and without flap elevation: an experimental study in the dog. *Clin Oral Implants Res.* 2009 Jun;20(6):545-9. doi: 10.1111/j.1600-0501.2008.01703.x. PMID: 19515033.

Techniques:

5. Lekovic V, Camargo PM, Klokkevold PR, Weinlaender M, Kenney EB, Dimitrijevic B, Nedic M. Preservation of alveolar bone in extraction sockets using bioabsorbable membranes. *J Periodontol.* 1998 Sep;69(9):1044-9. PMID: 9776033 DOI: 10.1902/jop.1998.69.9.1044.
6. Iasella JM, Greenwell H, Miller RL, Hill M, Drisko C, Bohra AA, Scheetz JP. Ridge preservation with freeze-dried bone allograft and a collagen membrane compared to extraction alone for implant site development: a

- clinical and histologic study in humans. *J Periodontol.* 2003 Jul;74(7):990-9. PMID: 12931761 DOI: 10.1902/jop.2003.74.7.990.
7. Elian N, Cho SC, Froum S, Smith RB, Tarnow DP. A simplified socket classification and repair technique. *Pract Proced Aesthet Dent.* 2007 Mar;19(2):99-104; quiz 106. PMID: 17491484.
 8. Araújo MG, Lindhe J. Ridge preservation with the use of Bio-Oss collagen: A 6-month study in the dog. *Clin Oral Implants Res.* 2009 May;20(5):433-40. PMID: 19522974 DOI: 10.1111/j.1600-0501.2009.01705.x.
 9. Kim DM, Nevins M, Camelo M, Schupbach P, Kim SW, Camelo JM, Al Hezaimi K, Nevins ML. The feasibility of demineralized bone matrix and cancellous bone chips in conjunction with an extracellular matrix membrane for alveolar ridge preservation: a case series. *Int J Periodontics Restorative Dent.* 2011 Feb;31(1):39-47. PMID: 21365025.
 10. Wood RA, Mealey BL. Histologic comparison of healing after tooth extraction with ridge preservation using mineralized versus demineralized freeze-dried bone allograft. *J Periodontol.* 2012 Mar;83(3):329-36. PMID: 21749166 DOI: 10.1902/jop.2011.110270.
 11. Hassan M, Prakasam S, Bain C, Ghoneima A, Liu SS. A randomized split-mouth clinical trial on effectiveness of amnion-chorion membranes in alveolar ridge preservation: a clinical, radiologic, and morphometric study. *Int J Oral Maxillofac Implants.* 2017 Nov/Dec;32(6):1389-1398. PMID: 29140383 DOI: 10.11607/jomi.5875.
 12. Demetter RS, Calahan BG, Mealey BL. Histologic evaluation of wound healing after ridge preservation with cortical, cancellous, and combined cortico-cancellous freeze-dried bone allograft: a randomized controlled clinical trial. *J Periodontol.* 2017 Sep;88(9):860-868. PMID: 28452622 DOI: 10.1902/jop.2017.170155.
 13. Srinivas B, Das P, Rana MM, Qureshi AQ, Vaidya KC, Ahmed Raziuuddin SJ. Wound healing and bone regeneration in postextraction sockets with and without platelet-rich fibrin. *Ann Maxillofac Surg.* 2018 Jan-Jun;8(1):28-34. PMID: 29963421 DOI: 10.4103/ams.ams_153_17.
 14. Avila-Ortiz G, Chambrone L, Vignoletti F. Effect of alveolar ridge preservation interventions following tooth extraction: a systematic review and meta-analysis. *J Clin Periodontol.* 2019 Jun;46 Suppl 21:195-223. PMID: 30623987 DOI: 10.1111/jcpe.13057.
 15. Corning PJ, Mealey BL. Ridge preservation following tooth extraction using mineralized freeze-dried bone allograft compared to mineralized solvent-dehydrated bone allograft: a randomized controlled clinical trial. *J Periodontol.* 2019 Feb;90(2):126-133. PMID: 30161278 DOI: 10.1002/JPER.18-0199.
 16. Al Hugail AM, Mealey BL, Walker C, Al Harthi S, Duong M, Noujeim M, Lasho DJ, Prihoda TJ, Huynh-Ba G. Evaluation of healing at molar extraction sites with ridge preservation using a non-resorbable dense polytetrafluoroethylene membrane: a four-arm cohort prospective study. *Clin Exp Dent Res.* 2021 Dec;7(6):1103-1111. PMID: 34096195 DOI: 10.1002/cre2.459.
 17. MacBeth ND, Donos N, Mardas N. Alveolar ridge preservation with guided bone regeneration or socket seal technique. A randomised, single-blind controlled clinical trial. *Clin Oral Implants Res.* 2022 Jul;33(7):681-699. PMID: 35488477 DOI: 10.1111/cir.13933.

Reviews:

1. Suárez-López Del Amo F, Monje A. Efficacy of biologics for alveolar ridge preservation/reconstruction and implant site development: An American Academy of Periodontology best evidence systematic review. *J Periodontol.* 2022 Dec;93(12):1827-1847. doi: 10.1002/JPER.22-0069. Epub 2022 Oct 24. PMID: 35841608; PMCID: PMC10092438.
2. Avila-Ortiz, G., Elangovan, S., Kramer, K. W., Blanchette, D., & Dawson, D. V. (2014). Effect of alveolar ridge preservation after tooth extraction: a systematic review and meta-analysis. *Journal of dental research*, 93(10), 950–958. <https://doi.org/10.1177/0022034514541127>. Epub 2014 Jun 25. PMID: 24922122 DOI: 10.1177/0022034514541127.

20.3 Guided Bone Regeneration

Questions to be answered from this topic:

- What are the principles needed to achieve a successful outcome in guided bone regeneration?
- What are some known complications of GBR procedures?
- What is the survival rate of implants in augmented ridges?

Classification of edentulous ridges:

1. Seibert JS. Reconstruction of deformed, partially edentulous ridges, using full thickness onlay grafts. Part I. Technique and wound healing. *Compend Contin Educ Dent* (Lawrenceville). 1983 Sep-Oct;4(5):437-53. PMID: 6578906.
2. Allen EP, Gainza CS, Farthing GG, Newbold DA. Improved technique for localized ridge augmentation. A report of 21 cases. *J Periodontol*. 1985 Apr;56(4):195-9. doi: 10.1902/jop.1985.56.4.195. PMID: 2987473.
3. Wang HL, Al-Shammari K. HVC ridge deficiency classification: a therapeutically oriented classification. *Int J Periodontics Restorative Dent*. 2002 Aug;22(4):335-43. PMID: 12212680.

Horizontal and vertical ridge augmentation, barrier membranes; particulate vs block grafts: autogenous, allografts, xenografts, alloplasts, biologics, growth factors, or combination

4. Nyman S, Lang NP, Buser D, Bragger U. Bone regeneration adjacent to titanium dental implants using guided tissue regeneration: a report of two cases. *Int J Oral Maxillofac Implants*. 1990 Spring;5(1):9-14. PMID: 2391139.
5. Dahlin C, Lekholm U, Linde A. Membrane-induced bone augmentation at titanium implants. A report on ten fixtures followed from 1 to 3 years after loading. *Int J Periodontics Restorative Dent*. 1991;11(4):273-81. PMID: 1810890.
6. Jovanovic SA, Spiekermann H, Richter EJ. Bone regeneration around titanium dental implants in dehisced defect sites: a clinical study. *Int J Oral Maxillofac Implants*. 1992 Summer;7(2):233-45. PMID: 1398841.
7. Vlassis JM, Wetzel AC, Caffesse RG. Guided bone regeneration at a fenestrated dental implant: histologic assessment of a case report. *Int J Oral Maxillofac Implants*. 1993;8(4):447-51. PMID: 8270315.
8. Buser D, Dula K, Belser U, Hirt HP, Berthold H. Localized ridge augmentation using guided bone regeneration. 1. Surgical procedure in the maxilla. *Int J Periodontics Restorative Dent*. 1993;13(1):29-45. PMID: 8330945.
9. Buser D, Ruskin J, Higginbottom F, Hardwick R, Dahlin C, Schenk RK. Osseointegration of titanium implants in bone regenerated in membrane-protected defects: a histologic study in the canine mandible. *Int J Oral Maxillofac Implants*. 1995 Nov-Dec;10(6):666-81. PMID: 8530169.
10. Jovanovic SA, Nevins M. Bone formation utilizing titanium-reinforced barrier membranes. *Int J Periodontics Restorative Dent*. 1995 Feb;15(1):56-69. PMID: 7591524..
11. Dahlin C, Lekholm U, Becker W, Becker B, Higuchi K, Callens A, van Steenberghe D. Treatment of fenestration and dehiscence bone defects around oral implants using the guided tissue regeneration technique: a prospective multicenter study. *Int J Oral Maxillofac Implants*. 1995 May-Jun;10(3):312-8. PMID: 7615327..
12. Tinti C, Parma-Benfenati S, Polizzi G. Vertical ridge augmentation: what is the limit? *Int J Periodontics Restorative Dent*. 1996 Jun;16(3):220-9. PMID: 9084308.
13. Piattelli M, Scarano A, Piattelli A. Vertical ridge augmentation using a resorbable membrane: a case report. *J Periodontol*. 1996 Feb;67(2):158-61. doi: 10.1902/jop.1996.67.2.158. PMID: 8667136. 129

14. Tinti C, Parma-Benfenati S. Vertical ridge augmentation: surgical protocol and retrospective evaluation of 48 consecutively inserted implants. *Int J Periodontics Restorative Dent.* 1998 Oct;18(5):434-43. PMID: 10093520.
15. Fugazzotto PA. Report of 302 consecutive ridge augmentation procedures: technical considerations and clinical results. *Int J Oral Maxillofac Implants.* 1998 May-Jun;13(3):358-68. PMID: 9638006.
16. Becker W, Dahlin C, Lekholm U, Bergstrom C, van Steenberghe D, Higuchi K, Becker BE. Five-year evaluation of implants placed at extraction and with dehiscences and fenestration defects augmented with ePTFE membranes: results from a prospective multicenter study. *Clin Implant Dent Relat Res.* 1999;1(1):27-32. doi: 10.1111/j.1708-8208.1999.tb00088.x. PMID: 11359308.
17. Parma-Benfenati S, Tinti C, Albrektsson T, Johansson C. Histologic evaluation of guided vertical ridge augmentation around implants in humans. *Int J Periodontics Restorative Dent.* 1999 Oct;19(5):424-37. PMID: 10709508
18. Machtei EE. The effect of membrane exposure on the outcome of regenerative procedures in humans: a meta-analysis. *J Periodontol.* 2001 Apr;72(4):512-6. doi: 10.1902/jop.2001.72.4.512. PMID: 11338304.
19. Wang HL, Misch C, Neiva RF. "Sandwich" bone augmentation technique: rationale and report of pilot cases. *Int J Periodontics Restorative Dent.* 2004 Jun;24(3):232-45. PMID: 15227771.
20. Wang HL, Boyapati L. "PASS" principles for predictable bone regeneration. *Implant Dent.* 2006 Mar;15(1):8-17. doi: 10.1097/01.id.0000204762.39826.0f. PMID: 16569956.
21. Rocchietta I, Fontana F, Simion M. Clinical outcomes of vertical bone augmentation to enable dental implant placement: a systematic review. *J Clin Periodontol.* 2008 Sep;35(8 Suppl):203-15. doi: 10.1111/j.1600-051X.2008.01271.x. PMID: 18724851.
22. Park YH, Choi SH, Cho KS, Lee JS. Dimensional alterations following vertical ridge augmentation using collagen membrane and three types of bone grafting materials: A retrospective observational study. *Clin Implant Dent Relat Res.* 2017 Aug;19(4):742-749. doi: 10.1111/cid.12502. Epub 2017 May 29. PMID: 28556452.
23. Urban IA, Monje A, Lozada J, Wang HL. Principles for Vertical Ridge Augmentation in the Atrophic Posterior Mandible: A Technical Review. *Int J Periodontics Restorative Dent.* 2017 Sep/Oct;37(5):639-645. doi: 10.11607/prd.3200. PMID: 28817126.
24. Chavda S, Levin L. Human Studies of Vertical and Horizontal Alveolar Ridge Augmentation Comparing Different Types of Bone Graft Materials: A Systematic Review. *J Oral Implantol.* 2018 Feb;44(1):74-84. doi: 10.1563/aaid-joi-D-17-00053. Epub 2017 Nov 14. PMID: 29135351.
25. Cucchi A, Sartori M, Aldini NN, Vignudelli E, Corinaldesi G. A Proposal of Pseudo-periosteum Classification After GBR by Means of Titanium-Reinforced d-PTFE Membranes or Titanium Meshes Plus Cross-Linked Collagen Membranes. *Int J Periodontics Restorative Dent.* 2019 Jul/Aug;39(4):e157-e165. doi: 10.11607/prd.e3598. PMID: 31226196.
26. Mendoza-Azpur G, de la Fuente A, Chavez E, Valdivia E, Khouly I. Horizontal ridge augmentation with guided bone regeneration using particulate xenogenic bone substitutes with or without autogenous block grafts: A randomized controlled trial. *Clin Implant Dent Relat Res.* 2019 Aug;21(4):521-530. doi: 10.1111/cid.12740. Epub 2019 Mar 18. PMID: 30884111.
27. Atef M, Tarek A, Shaheen M, Alarawi RM, Askar N. Horizontal ridge augmentation using native collagen membrane vs titanium mesh in atrophic maxillary ridges: Randomized clinical trial. *Clin Implant Dent Relat Res.* 2020 Apr;22(2):156-166. doi: 10.1111/cid.12892. Epub 2020 Mar 17. PMID: 32185856.
28. Starch-Jensen T, Deluiz D, Tinoco EMB. Horizontal Alveolar Ridge Augmentation with Allogeneic Bone Block Graft Compared with Autogenous Bone Block Graft: a Systematic Review. *J Oral Maxillofac Res.* 2020 Mar 31;11(1):e1. doi: 10.5037/jomr.2020.11101. PMID: 32377325; PMCID: PMC7191383..
29. Windisch P, Orban K, Salvi GE, Sculean A, Molnar B. Vertical-guided bone regeneration with a titanium-reinforced d-PTFE membrane utilizing a novel split-thickness flap design: a prospective case series. *Clin Oral Investig.* 2021 May;25(5):2969-2980. doi: 10.1007/s00784-020-03617-6. Epub 2020 Oct 10. PMID: 33040203; PMCID: PMC8060182.
31. Maiorana C, Fontana F, Dal Polo MR, Pieroni S, Ferrantino L, Poli PP, Simion M. Dense Polytetrafluoroethylene Membrane versus Titanium Mesh in Vertical Ridge Augmentation: Clinical and ¹³⁰

- Histological Results of a Split-mouth Prospective Study. *J Contemp Dent Pract.* 2021 May 1;22(5):465-472. PMID: 34318762.
32. Arnal HM, Angioni CD, Gaultier F, Urbinelli R, Urban IA. Horizontal guided bone regeneration on knife-edge ridges: A retrospective case-control pilot study comparing two surgical techniques. *Clin Implant Dent Relat Res.* 2022 Apr;24(2):211-221. doi: 10.1111/cid.13073. Epub 2022 Feb 15. PMID: 35167184.
 33. Palkovics D, Bolya-Orosz F, Pinter C, Molnar B, Windisch P. Reconstruction of vertical alveolar ridge deficiencies utilizing a high-density polytetrafluoroethylene membrane /clinical impact of flap dehiscence on treatment outcomes: case series/. *BMC Oral Health.* 2022 Nov 15;22(1):490. doi: 10.1186/s12903-022-02513-7. PMID: 36376891; PMCID: PMC9664701..
 34. Aboelela SAA, Atef M, Shawky M, Fattouh H. Ridge augmentation using autologous concentrated growth factors enriched bone graft matrix versus guided bone regeneration using native collagen membrane in horizontally deficient maxilla: A randomized clinical trial. *Clin Implant Dent Relat Res.* 2022 Oct;24(5):569-579. doi: 10.1111/cid.13121. Epub 2022 Jul 10. PMID: 35811435.
 35. Urban IA, Montero E, Amerio E, Palombo D, Monje A. Techniques on vertical ridge augmentation: Indications and effectiveness. *Periodontol 2000.* 2023 Jan 31. doi: 10.1111/prd.12471. Epub ahead of print. PMID: 36721380.
 36. Palkovics D, Solyom E, Somodi K, Pinter C, Windisch P, Bartha F, Molnar B. Three-dimensional volumetric assessment of hard tissue alterations following horizontal guided bone regeneration using a split-thickness flap design: A case series. *BMC Oral Health.* 2023 Feb 22;23(1):118. doi: 10.1186/s12903-023-02797-3. PMID: 36810076; PMCID: PMC9945662.

Decortication

37. Greenstein G, Greenstein B, Cavallaro J, Tarnow D. The role of bone decortication in enhancing the results of guided bone regeneration: a literature review. *J Periodontol.* 2009 Feb;80(2):175-89. doi: 10.1902/jop.2009.080309. PMID: 19186957.
38. Danesh-Sani SA, Tarnow D, Yip JK, Mojaver R. The influence of cortical bone perforation on guided bone regeneration in humans. *Int J Oral Maxillofac Surg.* 2017 Feb;46(2):261-266. doi: 10.1016/j.ijom.2016.10.017. Epub 2016 Nov 16. PMID: 27865631.

Ridge splits/expansion

39. Vercellotti T. Piezoelectric surgery in implantology: a case report--a new piezoelectric ridge expansion technique. *Int J Periodontics Restorative Dent.* 2000 Aug;20(4):358-65. PMID: 11203575.
40. de Souza CSV, de Sá BCM, Goulart D, Guillen GA, Macêdo FGC, Nôia CF. *Split Crest Technique with Immediate Implant to Treat Horizontal Defects of the Alveolar Ridge: Analysis of Increased Thickness and Implant Survival.* *J Maxillofac Oral Surg.* 2020 Dec;19(4):498-505. doi: 10.1007/s12663-020-01332-z. Epub 2020 Jan 18. PMID: 33071495; PMCID: PMC7524911.

Distraction osteogenesis

41. Zhao K, Wang F, Huang W, Wu Y. Clinical Outcomes of Vertical Distraction Osteogenesis for Dental Implantation: A Systematic Review and Meta-Analysis. *Int J Oral Maxillofac Implants.* 2018 May/Jun;33(3):549-564. doi: 10.11607/jomi.6140. PMID: 29763493.
42. Uckan S, Senol G, Ogut E, Muftuoglu G. Horizontal alveolar transport distraction osteogenesis followed by implant placement. *Int J Oral Maxillofac Surg.* 2019 Jun;48(6):824-829. doi: 10.1016/j.ijom.2018.11.001. Epub 2018 Nov 28. PMID: 30503636.

Implant success in grafted ridges

43. Simion M, Jovanovic SA, Trisi P, Scarano A, Piattelli A. Vertical ridge augmentation around dental implants using a membrane technique and autogenous bone or allografts in humans. *Int J Periodontics Restorative Dent.* 1998 Feb;18(1):8-23. PMID: 9558553.
44. Tran DT, Gay IC, Diaz-Rodriguez J, Parthasarathy K, Weltman R, Friedman L. Survival of Dental Implants Placed in Grafted and Nongrafted Bone: A Retrospective Study in a University Setting. *Int J Oral Maxillofac Implants.* 2016 Mar-Apr;31(2):310-7. doi: 10.11607/jomi.4681. PMID: 27004278.
45. Jung RE, Fenner N, Hämmmerle CH, Zitzmann NU. Long-term outcome of implants placed with guided bone regeneration (GBR) using resorbable and non-resorbable membranes after 12-14 years. *Clin Oral Implants Res.* 2013 Oct;24(10):1065-73. doi: 10.1111/j.1600-0501.2012.02522.x. Epub 2012 Jun 15. PMID: 22697628.
46. Marconcini S, Gianniaro E, Derchi G, Alfonsi F, Covani U, Barone A. Clinical outcomes of implants placed in ridge-preserved versus nonpreserved sites: A 4-year randomized clinical trial. *Clin Implant Dent Relat Res.* 2018 Dec;20(6):906-914. doi: 10.1111/cid.12682. Epub 2018 Oct 11. PMID: 30307130.

Reviews:

1. Hutmacher D, Hürzeler MB, Schliephake H. A review of material properties of biodegradable and bioresorbable polymers and devices for GTR and GBR applications. *Int J Oral Maxillofac Implants.* 1996 Sep-Oct;11(5):667-78. PMID: 8908867.
2. Fiorellini JP, Nevins ML. Localized ridge augmentation/preservation. A systematic review. *Ann Periodontol.* 2003 Dec;8(1):321-7. doi: 10.1902/annals.2003.8.1.321. PMID: 14971259.
3. Sanz-Sánchez I, Ortiz-Vigón A, Sanz-Martín I, Figuero E, Sanz M. Effectiveness of Lateral Bone Augmentation on the Alveolar Crest Dimension: A Systematic Review and Meta-analysis. *J Dent Res.* 2015 Sep;94(9 Suppl):128S-42S. doi: 10.1177/0022034515594780. Epub 2015 Jul 27. PMID: 26215467.
4. Cucchi A, Chierico A, Fontana F, Mazzocco F, Cinquegrana C, Belleggia F, Rossetti P, Soardi CM, Todisco M, Luongo R, Signorini L, Ronda M, Pistilli R. Statements and Recommendations for Guided Bone Regeneration: Consensus Report of the Guided Bone Regeneration Symposium Held in Bologna, October 15 to 16, 2016. *Implant Dent.* 2019 Aug;28(4):388-399. doi: 10.1097/ID.0000000000000909. PMID: 31344018.
5. Elnayef B, Porta C, Suárez-López Del Amo F, Mordini L, Gargallo-Albiol J, Hernández-Alfaro F. The Fate of Lateral Ridge Augmentation: A Systematic Review and Meta-Analysis. *Int J Oral Maxillofac Implants.* 2018 May/Jun;33(3):622-635. doi: 10.11607/jomi.6290. PMID: 29763500.
6. Lim G, Lin GH, Monje A, Chan HL, Wang HL. Wound Healing Complications Following Guided Bone Regeneration for Ridge Augmentation: A Systematic Review and Meta-Analysis. *Int J Oral Maxillofac Implants.* 2018 January/February;33(1):41–50. doi: 10.11607/jomi.5581. Epub 2017 Sep 22. PMID: 28938030.
7. Urban IA, Montero E, Monje A, Sanz-Sánchez I. Effectiveness of vertical ridge augmentation interventions: A systematic review and meta-analysis. *J Clin Periodontol.* 2019 Jun;46 Suppl 21:319-339. doi: 10.1111/jcpe.13061. PMID: 30667522.
8. Jepsen S, Schwarz F, Cordaro L, Derkx J, Hämmmerle CHF, Heitz-Mayfield LJ, Hernández-Alfaro F, Meijer HJA, Naenni N, Ortiz-Vigón A, Pjetursson B, Raghoebar GM, Renvert S, Rocchietta I, Roccuzzo M, Sanz-Sánchez I, Simion M, Tomasi C, Trombelli L, Urban I. Regeneration of alveolar ridge defects. Consensus report of group 4 of the 15th European Workshop on Periodontology on Bone Regeneration. *J Clin Periodontol.* 2019 Jun;46 Suppl 21:277-286. doi: 10.1111/jcpe.13121. PMID: 31038223.
9. Thoma DS, Bienz SP, Figuero E, Jung RE, Sanz-Martín I. Efficacy of lateral bone augmentation performed simultaneously with dental implant placement: A systematic review and meta-analysis. *J Clin Periodontol.* 2019 Jun;46 Suppl 21:257-276. doi: 10.1111/jcpe.13050. PMID: 30675733.

20.4 Sinus Augmentation

Questions to be answered from this topic:

- How do maxillary sinus anatomic considerations affect the outcome of sinus augmentation procedures?
- Provide an overview of materials and approaches utilized in lateral approach sinus augmentation.
- What is the rate of complications in sinus augmentation?

Anatomy

1. Kim MJ, Jung UW, Kim CS, Kim KD, Choi SH, Kim CK, Cho KS. Maxillary sinus septa: prevalence, height, location, and morphology. A reformatted computed tomography scan analysis. *J Periodontol.* 2006 May;77(5):903-8. doi: 10.1902/jop.2006.050247. PMID: 16671885.
2. Pommer B, Unger E, Sütö D, Hack N, Watzek G. Mechanical properties of the Schneiderian membrane in vitro. *Clin Oral Implants Res.* 2009 Jun;20(6):633-7. doi: 10.1111/j.1600-0501.2008.01686.x. Epub 2009 Mar 4. PMID: 19281504.
3. Avila G, Wang HL, Galindo-Moreno P, Misch CE, Bagramian RA, Rudek I, Benavides E, Moreno-Riestra I, Braun T, Neiva R. The influence of the bucco-palatal distance on sinus augmentation outcomes. *J Periodontol.* 2010 Jul;81(7):1041-50. doi: 10.1902/jop.2010.090686. PMID: 20450402.
4. Rosano G, Taschieri S, Gaudy JF, Weinstein T, Del Fabbro M. Maxillary sinus vascular anatomy and its relation to sinus lift surgery. *Clin Oral Implants Res.* 2011 Jul;22(7):711-715. doi: 10.1111/j.1600-0501.2010.02045.x. Epub 2010 Dec 9. PMID: 21143535.
5. Lin YH, Yang YC, Wen SC, Wang HL. The influence of sinus membrane thickness upon membrane perforation during lateral window sinus augmentation. *Clin Oral Implants Res.* 2016 May;27(5):612-7. doi: 10.1111/cir.12646. Epub 2015 Jun 16. PMID: 26076580.

Evaluation of sinus

6. Carmeli G, Artzi Z, Kozlovsky A, Segev Y, Landsberg R. Antral computerized tomography pre-operative evaluation: relationship between mucosal thickening and maxillary sinus function. *Clin Oral Implants Res.* 2011 Jan;22(1):78-82. doi: 10.1111/j.1600-0501.2010.01986.x. Epub 2010 Oct 13. PMID: 20946209.
7. Torretta S, Mantovani M, Testori T, Cappadona M, Pignataro L. Importance of ENT assessment in stratifying candidates for sinus floor elevation: a prospective clinical study. *Clin Oral Implants Res.* 2013 Aug;24 Suppl A100:57-62. doi: 10.1111/j.1600-0501.2011.02371.x. Epub 2011 Nov 22. PMID: 22107048.

Grafting Materials

8. Khoury F. Augmentation of the sinus floor with mandibular bone block and simultaneous implantation: a 6-year clinical investigation. *Int J Oral Maxillofac Implants.* 1999 Jul-Aug;14(4):557-64. PMID: 10453672.
9. Piattelli M, Favero GA, Scarano A, Orsini G, Piattelli A. Bone reactions to anorganic bovine bone (Bio-Oss) used in sinus augmentation procedures: a histologic long-term report of 20 cases in humans. *Int J Oral Maxillofac Implants.* 1999 Nov-Dec;14(6):835-40. PMID: 10612920.
10. Hallman M, Zetterqvist L. A 5-year prospective follow-up study of implant-supported fixed prostheses in patients subjected to maxillary sinus floor augmentation with an 80:20 mixture of bovine hydroxyapatite and autogenous bone. *Clin Implant Dent Relat Res.* 2004;6(2):82-9. doi: 10.1111/j.1708-8208.2004.tb00030.x. PMID: 15669708.
11. Thorwarth M, Srour S, Felszeghy E, Kessler P, Schultze-Mosgau S, Schlegel KA. Stability of autogenous bone grafts after sinus lift procedures: a comparative study between anterior and posterior aspects of the iliac crest and an intraoral donor site. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2005 Sep;100(3):278-84. doi: 10.1016/j.tripleo.2004.12.017. PMID: 16122653.
12. Scarano A, Degidi M, Iezzi G, Pecora G, Piattelli M, Orsini G, Caputi S, Perrotti V, Mangano C, Piattelli A. Maxillary sinus augmentation with different biomaterials: a comparative histologic and

- histomorphometric study in man. *Implant Dent.* 2006 Jun;15(2):197-207. doi: 10.1097/01.id.0000220120.54308.f3. PMID: 16766904.
13. Schwartz Z, Goldstein M, Raviv E, Hirsch A, Ranly DM, Boyan BD. Clinical evaluation of demineralized bone allograft in a hyaluronic acid carrier for sinus lift augmentation in humans: a computed tomography and histomorphometric study. *Clin Oral Implants Res.* 2007 Apr;18(2):204-11. doi: 10.1111/j.1600-0501.2006.01303.x. PMID: 17348885.
 14. Galindo-Moreno P, Avila G, Fernández-Barbero JE, Aguilar M, Sánchez-Fernández E, Cutando A, Wang HL. Evaluation of sinus floor elevation using a composite bone graft mixture. *Clin Oral Implants Res.* 2007 Jun;18(3):376-82. doi: 10.1111/j.1600-0501.2007.01337.x. Epub 2007 Mar 12. PMID: 17355356.
 15. Chen TW, Chang HS, Leung KW, Lai YL, Kao SY. Implant placement immediately after the lateral approach of the trap door window procedure to create a maxillary sinus lift without bone grafting: a 2-year retrospective evaluation of 47 implants in 33 patients. *J Oral Maxillofac Surg.* 2007 Nov;65(11):2324-8. doi: 10.1016/j.joms.2007.06.649. PMID: 17954333.

Barrier membranes

16. Tawil G, Mawla M. Sinus floor elevation using a bovine bone mineral (Bio-Oss) with or without the concomitant use of a bilayered collagen barrier (Bio-Gide): a clinical report of immediate and delayed implant placement. *Int J Oral Maxillofac Implants.* 2001 Sep-Oct;16(5):713-21. PMID: 11669254.
17. Wallace SS, Froum SJ, Cho SC, Elian N, Monteiro D, Kim BS, Tarnow DP. Sinus augmentation utilizing anorganic bovine bone (Bio-Oss) with absorbable and nonabsorbable membranes placed over the lateral window: histomorphometric and clinical analyses. *Int J Periodontics Restorative Dent.* 2005 Dec;25(6):551-9. PMID: 16353530.
18. Barone A, Ricci M, Grassi RF, Nannmark U, Quaranta A, Covani U. A 6-month histological analysis on maxillary sinus augmentation with and without use of collagen membranes over the osteotomy window: randomized clinical trial. *Clin Oral Implants Res.* 2013 Jan;24(1):1-6. doi: 10.1111/j.1600-0501.2011.02340.x. Epub 2011 Dec 12. PMID: 22151577.

Lateral Window Approach

19. Wallace SS, Froum SJ. Effect of maxillary sinus augmentation on the survival of endosseous dental implants. A systematic review. *Ann Periodontol.* 2003 Dec;8(1):328-43. doi: 10.1902/annals.2003.8.1.328. PMID: 14971260.
20. Pjetursson BE, Tan WC, Zwahlen M, Lang NP. A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. *J Clin Periodontol.* 2008 Sep;35(8 Suppl):216-40. doi: 10.1111/j.1600-051X.2008.01272.x. PMID: 18724852.

Transcrestal Approach

21. Summers RB. A new concept in maxillary implant surgery: the osteotome technique. *Compendium.* 1994 Feb;15(2):152, 154-6, 158 passim; quiz 162. PMID: 8055503.
22. Summers, R.B. Sinus Floor Elevation with Osteotomes. *J Esthet Dent.* 1998;10(3): 164-171. Doi:10.1111/j.1708-8240.1998.tb0030352.x.PMID: 9759033

Management of Complications

23. Pikos MA. Maxillary sinus membrane repair: report of a technique for large perforations. *Implant Dent.* 1999;8(1):29-34. doi: 10.1097/00008505-199901000-00003. PMID: 10356454.
24. Vlassis JM, Fugazzotto PA. A classification system for sinus membrane perforations during augmentation procedures with options for repair. *J Periodontol.* 1999 Jun;70(6):692-9. doi: 10.1902/jop.1999.70.6.692.¹³⁴

- PMID: 10397526.
25. Urban IA, Nagursky H, Church C, Lozada JL. Incidence, diagnosis, and treatment of sinus graft infection after sinus floor elevation: a clinical study. *Int J Oral Maxillofac Implants*. 2012 Mar-Apr;27(2):449-57. PMID: 22442787.

Review:

26. Garg AK. Augmentation grafting of the maxillary sinus for placement of dental implants: anatomy, physiology, and procedures. *Implant Dent*. 1999;8(1):36-46. doi: 10.1097/00008505-199901000-00004. PMID: 10356455.
27. Van den Bergh JP, ten Bruggenkate CM, Disch FJ, Tuinzing DB. Anatomical aspects of sinus floor elevations. *Clin Oral Implants Res*. 2000 Jun;11(3):256-65. doi: 10.1034/j.1600-0501.2000.011003256.x. PMID: 11168217.
28. Bell GW, Joshi BB, Macleod RI. Maxillary sinus disease: diagnosis and treatment. *Br Dent J*. 2011 Feb 12;210(3):113-8. doi: 10.1038/sj.bdj.2011.47. PMID: 21311531.
29. Wen SC, Chan HL, Wang HL. Classification and management of antral septa for maxillary sinus augmentation. *Int J Periodontics Restorative Dent*. 2013 Jul-Aug;33(4):509-17. doi: 10.11607/prd.1609. PMID: 23820711.
30. Lundgren S, Cricchio G, Hallman M, Jungner M, Rasmusson L, Sennerby L. Sinus floor elevation procedures to enable implant placement and integration: techniques, biological aspects and clinical outcomes. *Periodontol 2000*. 2017 Feb;73(1):103-120. doi: 10.1111/prd.12165. PMID: 28000271.

20.5 Peri-implant Soft Tissue Evaluation & Augmentation

Questions to be answered from this topic:

- What is the role of the peri-implant mucosa in establishing implant health?
- What are some available clinical evidence for establishing a minimal width and/or thickness of the peri-implant tissues?
- What are the surgical modalities and materials described in the literature for peri-implant tissue phenotype modification?
- Are non-autogenous materials/approaches used in peri-implant tissue augmentation comparable to traditional autogenous grafts?

1. Wennström JL, Bengazi F, Lekholm U. The influence of the masticatory mucosa on the peri-implant soft tissue condition. *Clin Oral Implants Res*. 1994;5(1):1-8. doi:10.1034/j.1600-0501.1994.050101.x Cited: 475
2. Ericsson I, Persson LG, Berglundh T, Marinello CP, Lindhe J, Klinge B. Different types of inflammatory reactions in peri-implant soft tissues. *J Clin Periodontol*. 1995;22(3):255-261. doi:10.1111/j.1600-051x.1995.tb00143.x Cited: 617
3. Romanos G, Grizas E, Nentwig GH. Association of Keratinized Mucosa and Periimplant Soft Tissue Stability Around Implants With Platform Switching. *Implant dentistry*. 2015;24(4):422-426. doi:10.1097/ID.0000000000000274 Cited: 47
4. Park WB, Kang KL, Han JY. Long-Term Clinical and Radiographic Observation of Periimplant Tissues After Autogenous Soft Tissue Grafts: A 15-Year Retrospective Study. *Implant dentistry*. 2017;26(5):762-769. doi:10.1097/ID.0000000000000656
5. Le B, Borzabadi-Farahani A, Nielsen B. Treatment of Labial Soft Tissue Recession Around Dental Implants in the Esthetic Zone Using Guided Bone Regeneration With Mineralized Allograft: A Retrospective Clinical Case Series. *J Oral Maxillofac Surg*. 2016;74(8):1552-1561. doi:10.1016/j.joms.2016.04.015. Cited: 40
6. Pranskunas M, Poskevicius L, Juodzbalys G, Kubilius R, Jimbo R. Influence of Peri-Implant Soft Tissue Condition and Plaque Accumulation on Peri-Implantitis: a Systematic Review. *J Oral Maxillofac Res*. 2016;7(3):e2. Published 2016 Sep 9. doi:10.5037/jomr.2016.7302 Cited: 100

7. Tavelli L, Barootchi S, Avila-Ortiz G, Urban IA, Giannobile WV, Wang HL. Peri-implant soft tissue phenotype modification and its impact on peri-implant health: A systematic review and network meta-analysis. *J Periodontol.* 2021;92(1):21-44. doi:10.1002/JPER.19-0716. Cited: 152
8. Thoma DS, Naenni N, Figuero E, et al. Effects of soft tissue augmentation procedures on peri-implant health or disease: A systematic review and meta-analysis. *Clin Oral Implants Res.* 2018;29 Suppl 15:32-49. doi:10.1111/clr.13114
9. Park SE, Da Silva JD, Weber HP, Ishikawa-Nagai S. Optical phenomenon of peri-implant soft tissue. Part I. Spectrophotometric assessment of natural tooth gingiva and peri-implant mucosa. *Clin Oral Implants Res.* 2007;18(5):569-574. doi:10.1111/j.1600-0501.2007.01391.x Cited: 223
10. Sanz-Martín I, Sanz-Sánchez I, Carrillo de Albornoz A, Figuero E, Sanz M. Effects of modified abutment characteristics on peri-implant soft tissue health: A systematic review and meta-analysis. *Clin Oral Implants Res.* 2018;29(1):118-129. doi:10.1111/clr.13097. Cited: 125
11. Cosgarea R, Gasparik C, Dudea D, Culic B, Dannewitz B, Sculean A. Peri-implant soft tissue colour around titanium and zirconia abutments: a prospective randomized controlled clinical study. *Clin Oral Implants Res.* 2015;26(5):537-544. doi:10.1111/clr.12440 Cited: 102
12. Gallucci GO, Grütter L, Chuang SK, Belser UC. Dimensional changes of peri-implant soft tissue over 2 years with single-implant crowns in the anterior maxilla. *J Clin Periodontol.* 2011;38(3):293-299. doi:10.1111/j.1600-051X.2010.01686.x Cited: 105
13. Schrott AR, Jimenez M, Hwang JW, Fiorellini J, Weber HP. Five-year evaluation of the influence of keratinized mucosa on peri-implant soft-tissue health and stability around implants supporting full-arch mandibular fixed prostheses. *Clin Oral Implants Res.* 2009;20(10):1170-1177. doi:10.1111/j.1600-0501.2009.01795.x Cited: 413
14. Khouri F, Happe A. Soft tissue management in oral implantology: a review of surgical techniques for shaping an esthetic and functional peri-implant soft tissue structure [published correction appears in Quintessence Int 2000 Sep;31(8):578. Hoppe, A [corrected to Happe, A]]. *Quintessence Int.* 2000;31(7):483-499. Cited: 142
15. Wittneben JG, Buser D, Belser UC, Brägger U. Peri-implant soft tissue conditioning with provisional restorations in the esthetic zone: the dynamic compression technique. *Int J Periodontics Restorative Dent.* 2013;33(4):447-455. doi:10.11607/prd.1268 Cited: 187
16. Tavelli L, McGuire MK, Zucchelli G, et al. Extracellular matrix-based scaffolding technologies for periodontal and peri-implant soft tissue regeneration. *J Periodontol.* 2020;91(1):17-25. doi:10.1002/JPER.19-0351. Cited: 103
17. Boora P, Rathee M, Bhoria M. Effect of Platelet Rich Fibrin (PRF) on Peri-implant Soft Tissue and Crestal Bone in One-Stage Implant Placement: A Randomized Controlled Trial. *J Clin Diagn Res.* 2015;9(4):ZC18-ZC21. doi:10.7860/JCDR/2015/12636.5788 Cited: 105
18. Zucchelli G, Tavelli L, Stefanini M, et al. Classification of facial peri-implant soft tissue dehiscence/deficiencies at single implant sites in the esthetic zone. *J Periodontol.* 2019;90(10):1116-1124. doi:10.1002/JPER.18-0616 Cited: 94
19. Cosgarea R, Gasparik C, Dudea D, Culic B, Dannewitz B, Sculean A. Peri-implant soft tissue colour around titanium and zirconia abutments: a prospective randomized controlled clinical study. *Clin Oral Implants Res.* 2015;26(5):537-544. doi:10.1111/clr.12440 Cited: 102
20. Kim A, Campbell SD, Viana MA, Knoernschild KL. Abutment Material Effect on Peri-implant Soft Tissue Color and Perceived Esthetics. *J Prosthodont.* 2016;25(8):634-640. doi:10.1111/jopr.12360 Cited: 77
21. Bonino F, Steffensen B, Natto Z, Hur Y, Holtzman LP, Weber HP. Prospective study of the impact of peri-implant soft tissue properties on patient-reported and clinically assessed outcomes. *J Periodontol.* 2018;89(9):1025-1032. doi:10.1002/JPER.18-0031 Cited: 37
22. Monaco C, Evangelisti E, Scotti R, Mignani G, Zucchelli G. A fully digital approach to replicate peri-implant soft tissue contours and emergence profile in the esthetic zone. *Clin Oral Implants Res.* 2016;27(12):1511-1514. doi:10.1111/clr.12599 Cited: 77
23. Bienz SP, Pirc M, Papageorgiou SN, Jung RE, Thoma DS. The influence of thin as compared to thick peri-implant soft tissues on aesthetic outcomes: A systematic review and meta-analysis. *Clin Oral Implants Res.* 2022;33 Suppl 23(Suppl 23):56-71. doi:10.1111/clr.13789 Cited: 8

24. Sanz-Martín I, Cha JK, Sanz-Sánchez I, Figuero E, Herrera D, Sanz M. Changes in peri-implant soft tissue levels following surgical treatment of peri-implantitis: A systematic review and meta-analysis. *Clin Oral Implants Res.* 2021;32 Suppl 21:230-244. doi:10.1111/clr.13840 Cited: 15
25. Suárez-López Del Amo F, Lin GH, Monje A, Galindo-Moreno P, Wang HL. Influence of Soft Tissue Thickness on Peri-Implant Marginal Bone Loss: A Systematic Review and Meta-Analysis. *J Periodontol.* 2016;87(6):690-699. doi:10.1902/jop.2016.150571 Cited: 230
26. Thoma DS, Naenni N, Figuero E, et al. Effects of soft tissue augmentation procedures on peri-implant health or disease: A systematic review and meta-analysis. *Clin Oral Implants Res.* 2018;29 Suppl 15:32-49. doi:10.1111/clr.13114 Cited: 346
27. Kim BS, Kim YK, Yun PY, et al. Evaluation of peri-implant tissue response according to the presence of keratinized mucosa. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2009;107(3):e24-e28. doi:10.1016/j.tripleo.2008.12.010 Cited: 264
28. Vervaeke S, Dierens M, Besseler J, De Bruyn H. The influence of initial soft tissue thickness on peri-implant bone remodeling. *Clin Implant Dent Relat Res.* 2014;16(2):238-247. doi:10.1111/j.1708-8208.2012.00474.x Cited: 155
29. Schneider D, Grunder U, Ender A, Hämmерle CH, Jung RE. Volume gain and stability of peri-implant tissue following bone and soft tissue augmentation: 1-year results from a prospective cohort study. *Clin Oral Implants Res.* 2011;22(1):28-37. doi:10.1111/j.1600-0501.2010.01987.x Cited: 241
30. Cairo F, Barbato L, Tonelli P, Batalocco G, Pagavino G, Nieri M. Xenogeneic collagen matrix versus connective tissue graft for buccal soft tissue augmentation at implant site. A randomized, controlled clinical trial. *J Clin Periodontol.* 2017;44(7):769-776. doi:10.1111/jcpe.12750

Reviews:

31. Cairo F, Pagliaro U, Nieri M. Soft tissue management at implant sites. *J Clin Periodontol.* 2008;35(8 Suppl):163-167. doi:10.1111/j.1600-051X.2008.01266.x Cited: 223
32. Sculean A, Romanos G, Schwarz F, et al. Soft-Tissue Management as Part of the Surgical Treatment of Periimplantitis: A Narrative Review. *Implant Dent.* 2019;28(2):210-216. doi:10.1097/ID.0000000000000870. Cited: 33
33. Mazzotti C, Stefanini M, Felice P, Bentivogli V, Mounssif I, Zucchelli G. Soft-tissue dehiscence coverage at peri-implant sites. *Periodontol 2000.* 2018;77(1):256-272. doi:10.1111/prd.12220Cited: 74
34. Sorni-Bröker M, Peñarrocha-Diago M, Peñarrocha-Diago M. Factors that influence the position of the peri-implant soft tissues: a review. *Med Oral Patol Oral Cir Bucal.* 2009;14(9):e475-e479. Published 2009 Sep 1. Cited: 48
35. Montero E, Molina A, Matesanz P, Monje A, Sanz-Sánchez I, Herrera D. Efficacy of soft tissue substitutes, in comparison with autogenous grafts, in surgical procedures aiming to increase the peri-implant keratinized mucosa: A systematic review. *Clin Oral Implants Res.* 2022;33 Suppl 23:32-46. doi:10.1111/clr.13751

21. Immediate implant placement and provisionalization

Questions to be answered from this topic:

- What factors are taken into consideration when deciding whether to place an implant via an immediate, early, or delayed approach?
- What are the success rates of anterior and molar immediate implants?
- How successful are immediate implants when compared to early and delayed implant placement?
- What is the ideal site morphology for immediate implant placement?
- Can immediate implants be placed in sites with infections/periapical pathologies?
- What are the average alterations in ridge dimensions following immediate implant placement?
- What factors affect hard tissue alterations following immediate implant placement?

- Do bone grafting or regenerative procedures at the time of immediate implant placement reduce changes in ridge dimensions?
- What are the esthetic outcomes and concerns related to immediate implants
- Do we need provisionalization of immediate implants for better outcomes?

21.1 Classification of implant placement timing

1. Hämmерle CH, Chen ST, Wilson TG Jr. Consensus statements and recommended clinical procedures regarding the placement of implants in extraction sockets. *Int J Oral Maxillofac Implants.* 2004;19 Suppl:26-8. PMID: 15635943.
2. Funato A, Salama MA, Ishikawa T, Garber DA, Salama H. Timing, positioning, and sequential staging in esthetic implant therapy: a four-dimensional perspective. *Int J Periodontics Restorative Dent.* 2007 Aug;27(4):313-23. PMID: 17726987.
3. Schropp L, Isidor F. Timing of implant placement relative to tooth extraction. *J Oral Rehabil.* 2008 Jan;35 Suppl 1:33-43. doi: 10.1111/j.1365-2842.2007.01827.x. PMID: 18181932.
4. Esposito M, Grusovin MG, Polyzos IP, Felice P, Worthington HV. Timing of implant placement after tooth extraction: immediate, immediate-delayed or delayed implants? A Cochrane systematic review. *Eur J Oral Implantol.* 2010 Autumn;3(3):189-205. PMID: 20847990.
5. Buser D, Chappuis V, Belser UC, Chen S. Implant placement post extraction in esthetic single tooth sites: when immediate, when early, when late? *Periodontol 2000.* 2017 Feb;73(1):84-102. doi: 10.1111/prd.12170. PMID: 28000278.

22.2 Success rate of immediately placed implants

1. Rosenquist B, Grenthe B. Immediate placement of implants into extraction sockets: implant survival. *Int J Oral Maxillofac Implants.* 1996 Mar-Apr;11(2):205-9. PMID: 8666452.
2. Schropp L, Wenzel A, Stavropoulos A. Early, delayed, or late single implant placement: 10-year results from a randomized controlled clinical trial. *Clin Oral Implants Res.* 2014 Dec;25(12):1359-65. doi: 10.1111/cir.12273. Epub 2013 Oct 8. PMID: 25040354.
3. Smith RB, Tarnow DP, Sarnachiaro G. Immediate Placement of Dental Implants in Molar Extraction Sockets: An 11-Year Retrospective Analysis. *Compend Contin Educ Dent.* 2019 Mar;40(3):166-170. PMID: 30829500.
4. Chen ST, Wilson TG Jr, Hämmérle CH. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures, and outcomes. *Int J Oral Maxillofac Implants.* 2004;19 Suppl:12-25. PMID: 15635942.
5. Lang NP, Pun L, Lau KY, Li KY, Wong MC. A systematic review on survival and success rates of implants placed immediately into fresh extraction sockets after at least 1 year. *Clin Oral Implants Res.* 2012 Feb;23 Suppl 5:39-66. doi: 10.1111/j.1600-0501.2011.02372.x. PMID: 22211305.
6. Mello CC, Lemos CAA, Verri FR, Dos Santos DM, Goiato MC, Pellizzer EP. Immediate implant placement into fresh extraction sockets versus delayed implants into healed sockets: A systematic review and meta-analysis. *Int J Oral Maxillofac Surg.* 2017 Sep;46(9):1162-1177. doi: 10.1016/j.ijom.2017.03.016. Epub 2017 May 3. PMID: 28478869.
7. Canellas JVDS, Medeiros PJD, Figueiredo CMDS, Fischer RG, Ritto FG. Which is the best choice after tooth extraction, immediate implant placement or delayed placement with alveolar ridge preservation? A systematic review and meta-analysis. *J Craniomaxillofac Surg.* 2019 Nov;47(11):1793-1802. doi: 10.1016/j.jcms.2019.08.004. Epub 2019 Aug 27. PMID: 31522823.
8. Ragucci GM, Elnayef B, Criado-Cámara E, Del Amo FS, Hernández-Alfaro F. Immediate implant placement in molar extraction sockets: a systematic review and meta-analysis. *Int J Implant Dent.* 2020 Oct 13;6(1):40. doi: 10.1186/s40729-020-00235-5. PMID: 32770283; PMCID: PMC7413966.

21.3 Treatment planning immediate implants

1. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. *J Periodontol.* 1992 Dec;63(12):995-6. doi: 10.1902/jop.1992.63.12.995. PMID: 1474471.
2. Tarnow D, Elian N, Fletcher P, Froum S, Magner A, Cho SC, Salama M, Salama H, Garber DA. Vertical distance from the crest of bone to the height of the interproximal papilla between adjacent implants. *J Periodontol.* 2003 Dec;74(12):1785-8. doi: 10.1902/jop.2003.74.12.1785. PMID: 14974820.
3. Gastaldo JF, Cury PR, Sendyk WR. Effect of the vertical and horizontal distances between adjacent implants and between a tooth and an implant on the incidence of interproximal papilla. *J Periodontol.* 2004 Sep;75(9):1242-6. doi: 10.1902/jop.2004.75.9.1242. PMID: 15515340.
4. Romeo E, Lops D, Rossi A, Storelli S, Rozza R, Chiapasco M. Surgical and prosthetic management of interproximal region with single-implant restorations: 1-year prospective study. *J Periodontol.* 2008 Jun;79(6):1048-55. doi: 10.1902/jop.2008.070431. PMID: 18533782.
5. Huynh-Ba G, Pjetursson BE, Sanz M, Cecchinato D, Ferrus J, Lindhe J, Lang NP. Analysis of the socket bone wall dimensions in the upper maxilla in relation to immediate implant placement. *Clin Oral Implants Res.* 2010 Jan;21(1):37-42. doi: 10.1111/j.1600-0501.2009.01870.x. PMID: 20070745.
6. Kan JY, Roe P, Rungcharassaeng K, Patel RD, Waki T, Lozada JL, Zimmerman G. Classification of sagittal root position in relation to the anterior maxillary osseous housing for immediate implant placement: a cone beam computed tomography study. *Int J Oral Maxillofac Implants.* 2011 Jul-Aug;26(4):873-6. PMID: 21841998.
7. Waasdorp JA, Evian CI, Mandracchia M. Immediate placement of implants into infected sites: a systematic review of the literature. *J Periodontol.* 2010 Jun;81(6):801-8. doi: 10.1902/jop.2010.090706. PMID: 20192616.
8. Bell CL, Diehl D, Bell BM, Bell RE. The immediate placement of dental implants into extraction sites with periapical lesions: a retrospective chart review. *J Oral Maxillofac Surg.* 2011 Jun;69(6):1623-7. doi: 10.1016/j.joms.2011.01.022. Epub 2011 Apr 15. PMID: 21496987.
9. Smith RB, Tarnow DP. Classification of molar extraction sites for immediate dental implant placement: technical note. *Int J Oral Maxillofac Implants.* 2013 May-Jun;28(3):911-6. doi: 10.11607/jomi.2627. PMID: 23748327.
10. Chrcanovic BR, Martins MD, Wennerberg A. Immediate placement of implants into infected sites: a systematic review. *Clin Implant Dent Relat Res.* 2015 Jan;17 Suppl 1:e1-e16. doi: 10.1111/cid.12098. Epub 2013 Jul 2. PMID: 23815434.
11. Gluckman H, Pontes CC, Du Toit J. Radial plane tooth position and bone wall dimensions in the anterior maxilla: A CBCT classification for immediate implant placement. *J Prosthet Dent.* 2018 Jul;120(1):50-56. doi: 10.1016/j.prosdent.2017.09.005. Epub 2017 Nov 29. PMID: 29195817.

21.4 Ridge dimensions after immediate implant placement

1. Covani U, Bortolaia C, Barone A, Sbordone L. Bucco-lingual crestal bone changes after immediate and delayed implant placement. *J Periodontol.* 2004 Dec;75(12):1605-12. doi: 10.1902/jop.2004.75.12.1605. PMID: 15732861.
2. Botticelli D, Berglundh T, Lindhe J. Hard-tissue alterations following immediate implant placement in extraction sites. *J Clin Periodontol.* 2004 Oct;31(10):820-8. doi: 10.1111/j.1600-051X.2004.00565.x. PMID: 15367183.
3. Matarasso S, Salvi GE, Iorio Siciliano V, Cafiero C, Blasi A, Lang NP. Dimensional ridge alterations following immediate implant placement in molar extraction sites: a six-month prospective cohort study with surgical re-entry. *Clin Oral Implants Res.* 2009 Oct;20(10):1092-8. doi: 10.1111/j.1600-0501.2009.01803.x. Epub 2009 Aug 30. PMID: 19719737.
4. Ferrus J, Cecchinato D, Pjetursson EB, Lang NP, Sanz M, Lindhe J. Factors influencing ridge alterations following immediate implant placement into extraction sockets. *Clin Oral Implants Res.* 2010 Jan;21(1):22-9. doi: 10.1111/j.1600-0501.2009.01825.x. Epub 2009 Nov 13. PMID: 19912273.

5. Tomasi C, Sanz M, Cecchinato D, Pjetursson B, Ferrus J, Lang NP, Lindhe J. Bone dimensional variations at implants placed in fresh extraction sockets: a multilevel multivariate analysis. *Clin Oral Implants Res.* 2010 Jan;21(1):30-6. doi: 10.1111/j.1600-0501.2009.01848.x. PMID: 20070744.
6. Lee CT, Chiu TS, Chuang SK, Tarnow D, Stoupel J. Alterations of the bone dimension following immediate implant placement into extraction socket: systematic review and meta-analysis. *J Clin Periodontol.* 2014 Sep;41(9):914-26. doi: 10.1111/jcpe.12276. Epub 2014 Jul 23. PMID: 24894299.
7. Clementini M, Tiravia L, De Risi V, Vittorini Orgeas G, Mannocci A, de Sanctis M. Dimensional changes after immediate implant placement with or without simultaneous regenerative procedures: a systematic review and meta-analysis. *J Clin Periodontol.* 2015 Jul;42(7):666-77. doi: 10.1111/jcpe.12423. Epub 2015 Jul 14. PMID: 26073267.

21.5 Horizontal defect dimension/jumping distance management

1. Botticelli D, Berglundh T, Buser D, Lindhe J. The jumping distance revisited: An experimental study in the dog. *Clin Oral Implants Res.* 2003 Feb;14(1):35-42. doi: 10.1034/j.1600-0501.2003.140105.x. PMID: 12562363.
2. Chen ST, Darby IB, Adams GG, Reynolds EC. A prospective clinical study of bone augmentation techniques at immediate implants. *Clin Oral Implants Res.* 2005 Apr;16(2):176-84. doi: 10.1111/j.1600-0501.2004.01093.x. PMID: 15777327.
3. Araújo MG, Linder E, Lindhe J. Bio-Oss collagen in the buccal gap at immediate implants: a 6-month study in the dog. *Clin Oral Implants Res.* 2011 Jan;22(1):1-8. doi: 10.1111/j.1600-0501.2010.01920.x. Epub 2010 Nov 22. PMID: 21091538.
4. Naji BM, Abdelsameaa SS, Alqutaibi AY, Said Ahmed WM. Immediate dental implant placement with a horizontal gap more than two millimetres: a randomized clinical trial. *Int J Oral Maxillofac Surg.* 2021 May;50(5):683-690. doi: 10.1016/j.ijom.2020.08.015. Epub 2020 Sep 18. PMID: 32951965.
5. Seyssens L, Eeckhout C, Cosyn J. Immediate implant placement with or without socket grafting: A systematic review and meta-analysis. *Clin Implant Dent Relat Res.* 2022 Jun;24(3):339-351. doi: 10.1111/cid.13079. Epub 2022 Mar 21. PMID: 35313067.

21.6 Esthetic consideration

1. Slagter KW, Meijer HJA, Hentenaar DFM, Vissink A, Raghoebar GM. Immediate single-tooth implant placement with simultaneous bone augmentation versus delayed implant placement after alveolar ridge preservation in bony defect sites in the esthetic region: A 5-year randomized controlled trial. *J Periodontol.* 2021 Dec;92(12):1738-1748. doi: 10.1002/JPER.20-0845. Epub 2021 Apr 3. PMID: 33724473.
2. Seyssens L, Eghbali A, Cosyn J. A 10-year prospective study on single immediate implants. *J Clin Periodontol.* 2020 Oct;47(10):1248-1258. doi: 10.1111/jcpe.13352. Epub 2020 Sep 2. PMID: 32748983.
3. Chen ST, Buser D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla--a systematic review. *Int J Oral Maxillofac Implants.* 2014;29 Suppl:186-215. doi: 10.11607/jomi.2014suppl.g3.3. PMID: 24660198.
4. Ramanauskaitė A, Sader R. Esthetic complications in implant dentistry. *Periodontol 2000.* 2022 Feb;88(1):73-85. doi: 10.1111/prd.12412. PMID: 35103323.

21.7 Immediate loading

1. den Hartog L, Raghoebar GM, Stellingsma K, Vissink A, Meijer HJ. Immediate non-occlusal loading of single implants in the aesthetic zone: a randomized clinical trial. *J Clin Periodontol.* 2011 Feb;38(2):186-94. doi: 10.1111/j.1600-051X.2010.01650.x. Epub 2010 Nov 18. PMID: 21087294.
2. Cabello G, Rioboo M, Fábrega JG. Immediate placement and restoration of implants in the aesthetic zone with a trimodal approach: soft tissue alterations and its relation to gingival biotype. *Clin Oral Implants Res.*

- 2013 Oct;24(10):1094-100. doi: 10.1111/j.1600-0501.2012.02516.x. Epub 2012 Jul 9. PMID: 22775590.
3. van Nimwegen WG, Raghoebar GM, Zuiderveld EG, Jung RE, Meijer HJA, Mühlemann S. Immediate placement and provisionalization of implants in the aesthetic zone with or without a connective tissue graft: A 1-year randomized controlled trial and volumetric study. *Clin Oral Implants Res.* 2018 Jul;29(7):671-678. doi: 10.1111/clr.13258. Epub 2018 May 27. PMID: 29806181; PMCID: PMC6099353.
 4. Slagter KW, Raghoebar GM, Hentenaar DFM, Vissink A, Meijer HJA. Immediate placement of single implants with or without immediate provisionalization in the maxillary aesthetic region: A 5-year comparative study. *J Clin Periodontol.* 2021 Feb;48(2):272-283. doi: 10.1111/jcpe.13398. Epub 2020 Nov 25. PMID: 33141935; PMCID: PMC7839711..
 5. Benic GI, Mir-Mari J, Hämmérle CH. Loading protocols for single-implant crowns: a systematic review and meta-analysis. *Int J Oral Maxillofac Implants.* 2014;29 Suppl:222-38. doi: 10.11607/jomi.2014suppl.g4.1. PMID: 24660200.
- ## **22. Peri-implant diseases**
- ### **22.1 Epidemiology**
1. Adell R, Lekholm U, Rockler B, Branemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. *Int J Oral Surg.* 1981;10:387-416.
 2. Froum SJ, Rosen PS. A proposed classification for peri-implantitis. *Int J Periodontics Restorative Dent.* 2012;32:533-540.
 3. Daubert DM, Weinstein BF, Bordin S, Leroux BG, Flemming TF. Prevalence and predictive factors for peri-implant disease and implant failure: a cross-sectional analysis. *J Periodontol.* 2015;86(3):337-347. doi:10.1902/jop.2014.140438.
 4. Derks J, Schaller D, Hakansson J, Wennstrom JL, Tomasi C, Berglundh T. Effectiveness of Implant Therapy Analyzed in a Swedish Population: Prevalence of Peri-implantitis. *J Dent Res.* 2016;95:43-49.
 5. Derks J, Schaller D, Hakansson J, Wennstrom JL, Tomasi C, Berglundh T. Peri-implantitis - onset and pattern of progression. *J Clin Periodontol.* 2016;43:383-388.
 6. Dalago HR, Schuldt Filho G, Rodrigues MA, Renvert S, Bianchini MA. Risk indicators for Peri-implantitis. A cross-sectional study with 916 implants. *Clin Oral Implants Res.* 2017 Feb;28(2):144-150. doi: 10.1111/clr.12772. PMID: 26754342.
 7. Chrcanovic BR, Kisch J, Albrektsson T, Wennerberg A. A retrospective study on clinical and radiological outcomes of oral implants in patients followed up for a minimum of 20 years. *Clin Implant Dent Relat Res.* 2018;20:199-207.
- ### **22.2 Pathogenesis**
1. Berglundh T, Lindhe J, Marinello C, Ericsson I, Liljenberg B. Soft tissue reaction to de novo plaque formation on implants and teeth. An experimental study in the dog. *Clin Oral Implants Res.* 1992;3:1-8.
 2. Albouy JP, Abrahamsson I, Persson LG, Berglundh T. Spontaneous progression of peri-implantitis at different types of implants. An experimental study in dogs. I: clinical and radiographic observations. *Clin Oral Implants Res.* 2008;19:997-1002.
 3. Trisi P, Perfetti G, Baldoni E, Berardi D, Colagiovanni M, Scogna G. Implant micromotion is related to peak insertion torque and bone density. *Clin Oral Implants Res.* 2009;20:467-471.
 4. Albouy JP, Abrahamsson I, Persson LG, Berglundh T. Spontaneous progression of ligatured induced peri-implantitis at implants with different surface characteristics. An experimental study in dogs II: histological observations. *Clin Oral Implants Res.* 2009;20:366-371.

5. Salvi GE, Aglietta M, Eick S, Sculean A, Lang NP, Ramseier CA. Reversibility of experimental peri-implant mucositis compared with experimental gingivitis in humans. *Clin Oral Implants Res.* 2012;23:182-190.
6. Carcuac O, Berglundh T. Composition of human peri-implantitis and periodontitis lesions. *J Dent Res.* 2014;93:1083-1088.

22.3 Etiology and risk factors

History of periodontitis:

1. Roos-Jansaker AM, Lindahl C, Renvert H, Renvert S. Nine- to fourteen-year follow-up of implant treatment. Part II: presence of peri-implant lesions. *J Clin Periodontol.* 2006;33:290-295.
2. Roos-Jansaker AM, Renvert H, Lindahl C, Renvert S. Nine- to fourteen-year follow-up of implant treatment. Part III: factors associated with peri-implant lesions. *J Clin Periodontol.* 2006;33:296-301.
3. Karoussis IK, Salvi GE, Heitz-Mayfield LJ, Bragger U, Hammerle CH, Lang NP. Long-term implant prognosis in patients with and without a history of chronic periodontitis: a 10-year prospective cohort study of the ITI Dental Implant System. *Clin Oral Implants Res.* 2003;14:329-339.
4. Karoussis IK, Kotsovilis S, Fourmousis I. A comprehensive and critical review of dental implant prognosis in periodontally compromised partially edentulous patients. *Clin Oral Implants Res.* 2007 Dec;18(6):669-79. doi: 10.1111/j.1600-0501.2007.01406.x. Epub 2007 Sep 13. PMID: 17868376.
5. Koldsland OC, Scheie AA, Aass AM. Prevalence of peri-implantitis related to severity of the disease with different degrees of bone loss. *J Periodontol.* 2010;81:231-238.
6. Roccuzzo M, De Angelis N, Bonino L, Aglietta M. Ten-year results of a three-arm prospective cohort study on implants in periodontally compromised patients. Part 1: implant loss and radiographic bone loss. *Clin Oral Implants Res.* 2010;21:490-496.
7. Daubert DM, Weinstein BF, Bordin S, Leroux BG, Flemming TF. Prevalence and predictive factors for peri-implant disease and implant failure: a cross-sectional analysis. *J Periodontol.* 2015;86:337-347.
8. Marrone A, Lasserre J, Bercy P, Brech MC. Prevalence and risk factors for peri-implant disease in Belgian adults. *Clin Oral Implants Res.* 2013;24:934-940.

Poor oral hygiene & irregular maintenance:

1. Monje A, Wang HL, Nart J. Association of Preventive Maintenance Therapy Compliance and Peri-Implant Diseases: A Cross-Sectional Study. *J Periodontol.* 2017;88:1030-1041.
2. Rokn A, Aslroosta H, Akbari S, Najafi H, Zayeri F, Hashemi K. Prevalence of peri-implantitis in patients not participating in well-designed supportive periodontal treatments: a cross-sectional study. *Clin Oral Implants Res.* 2017;28:314-319.
3. Costa FO, Takenaka-Martinez S, Cota LO, Ferreira SD, Silva GL, Costa JE. Peri-implant disease in subjects with and without preventive maintenance: a 5-year follow-up. *J Clin Periodontol.* 2012;39:173-181.

Smoking:

1. Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. Clinical results and marginal bone loss. *Clin Oral Implants Res.* 1996;7:329-336.
2. Renvert S, Aghazadeh A, Hallstrom H, Persson GR. Factors related to peri-implantitis - a retrospective study. *Clin Oral Implants Res.* 2014;25:522-529.

3. Bain CA, Moy PK. The association between the failure of dental implants and cigarette smoking. *Int J Oral Maxillofac Implants*. 1993;8:609-615.

Diabetes mellitus:

1. Gomez-Moreno G, Aguilar-Salvaterra A, Rubio Roldan J, Guardia J, Gargallo J, Calvo-Guirado JL. Peri-implant evaluation in type 2 diabetes mellitus patients: a 3-year study. *Clin Oral Implants Res*. 2015;26:1031-1035.
2. Tawil G, Younan R, Azar P, Sleilati G. Conventional and advanced implant treatment in the type II diabetic patient: surgical protocol and long-term clinical results. *Int J Oral Maxillofac Implants*. 2008;23:744-752.
3. Eskow CC, Oates TW. Dental Implant Survival and Complication Rate over 2 Years for Individuals with Poorly Controlled Type 2 Diabetes Mellitus. *Clin Implant Dent Relat Res*. 2017;19:423-431.

Osteoporosis & medication-related complications:

1. Fugazzotto PA, Lightfoot WS, Jaffin R, Kumar A. Implant placement with or without simultaneous tooth extraction in patients taking oral bisphosphonates: postoperative healing, early follow-up, and the incidence of complications in two private practices. *J Periodontol*. 2007;78:1664-1669.
2. Holahan CM, Koka S, Kennel KA, et al. Effect of osteoporotic status on the survival of titanium dental implants. *Int J Oral Maxillofac Implants*. 2008;23:905-910.

Foreign body & cement:

1. Wilson TG Jr., Valderrama P, Burbano M, et al. Foreign bodies associated with peri-implantitis human biopsies. *J Periodontol*. 2015;86:9-15.
2. Safioti LM, Kotsakis GA, Pozhitkov AE, Chung WO, Daubert DM. Increased Levels of Dissolved Titanium Are Associated With Peri-Implantitis - A Cross-Sectional Study. *J Periodontol*. 2017;88:436-442.
3. Wilson TG Jr. The positive relationship between excess cement and peri-implant disease: a prospective clinical endoscopic study. *J Periodontol*. 2009;80:1388-1392.
4. Linkevicius T, Puisys A, Vindasiute E, Linkeviciene L, Apse P. Does residual cement around implant-supported restorations cause peri-implant disease? A retrospective case analysis. *Clin Oral Implants Res*. 2013;24:1179-1184.

Microbiology:

1. Persson GR, Renvert S. Cluster of bacteria associated with peri-implantitis. *Clin Implant Dent Relat Res*. 2014;16:783-793.
2. Zhuang LF, Watt RM, Mattheos N, Si MS, Lai HC, Lang NP. Periodontal and peri-implant microbiota in patients with healthy and inflamed periodontal and peri-implant tissues. *Clin Oral Implants Res*. 2016;27:13-21.
3. Leonhardt A, Renvert S, Dahlen G. Microbial findings at failing implants. *Clin Oral Implants Res*. 1999;10:339-345.
4. Rosenberg ES, Torosian JP, Slots J. Microbial differences in 2 clinically distinct types of failures of osseointegrated implants. *Clin Oral Implants Res*. 1991;2:135-144.
5. Mombelli A, van Oosten MA, Schurch E Jr., Land NP. The microbiota associated with successful or failing osseointegrated titanium implants. *Oral Microbiol Immunol*. 1987;2:145-151.

Patient & operator factors:

1. Rocuzzo M, Grasso G, Dalmasso P. Keratinized mucosa around implants in partially edentulous posterior mandible: 10-year results of a prospective comparative study. *Clin Oral Implants Res*. 143

2016;27:491-496.

2. Katafuchi M, Weinstein BF, Leroux BG, Chen YW, Daubert DM. Restoration contour is a risk indicator for peri-implantitis: A cross-sectional radiographic analysis. *J Clin Periodontol.* 2018;45:225-232.
3. Canullo L, Tallarico M, Radovanovic S, Delibasic B, Covani U, Rakic M. Distinguishing predictive profiles for patient-based risk assessment and diagnostics of plaque induced, surgically and prosthetically triggered peri-implantitis. *Clin Oral Implants Res.* 2016;27:1243-1250.
4. Kozlovsky A, Tal H, Laufer BZ, et al. Impact of implant overloading on the peri-implant bone in inflamed and non-inflamed peri-implant mucosa. *Clin Oral Implants Res.* 2007;18:601-610.
5. Bashutski JD, D'Silva NJ, Wang HL. Implant compression necrosis: current understanding and case report. *J Periodontol.* 2009;80:700-704.
6. Eriksson AR, Albrektsson T, Albrektsson B. Heat caused by drilling cortical bone. Temperature measured in vivo in patients and animals. *Acta Orthop Scand.* 1984;55:629-631.
7. Gruica B, Wang HY, Lang NP, Buser D. Impact of IL-1 genotype and smoking status on the prognosis of osseointegrated implants. *Clin Oral Implants Res.* 2004;15:393-400.

Reviews:

Epidemiology & pathogenesis:

1. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int J Oral Maxillofac Implants.* 1986;1:11-25.
2. Lindhe J, Meyle J; Group D of European Workshop on Periodontology. Peri-implant diseases: Consensus Report of the Sixth European Workshop on Periodontology. *J Clin Periodontol.* 2008 Sep;35(8 Suppl):282-5. doi: 10.1111/j.1600-051X.2008.01283.x. PMID: 18724855.
3. Heitz-Mayfield LJ. Peri-implant diseases: diagnosis and risk indicators. *J Clin Periodontol.* 2008 Sep;35(8 Suppl):292-304. doi: 10.1111/j.1600-051X.2008.01275.x. PMID: 18724857.
4. Berglundh T, Zitzmann NU, Donati M. Are peri-implantitis lesions different from periodontitis lesions? *J Clin Periodontol.* 2011;38 Suppl 11:188-202.
5. Mombelli A, Müller N, Cionca N. The epidemiology of peri-implantitis. *Clin Oral Implants Res.* 2012 Oct;23 Suppl 6:67-76. doi: 10.1111/j.1600-0501.2012.02541.x. PMID: 23062130.
6. Derkx J, Tomasi C. Peri-implant health and disease. A systematic review of current epidemiology. *J Clin Periodontol.* 2015;42 Suppl 16:S158-171.
7. Jepsen S, Berglundh T, Genco R, et al. Primary prevention of peri-implantitis: managing peri-implant mucositis. *J Clin Periodontol.* 2015;42 Suppl 16:S152-157.
8. Lee CT, Huang YW, Zhu L, Weltman R. Prevalences of peri-implantitis and peri-implant mucositis: systematic review and meta-analysis. *J Dent.* 2017 Jul;62:1-12. doi: 10.1016/j.jdent.2017.04.011. Epub 2017 May 3. PMID: 28478213.
9. Schwarz F, Derkx J, Monje A, Wang HL. Peri-implantitis. *J Periodontol.* 2018;89 Suppl 1:S267-S290.
10. Berglundh T, Armitage G, Araujo MG, et al. Peri-implant diseases and conditions: Consensus report of workgroup 4 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Periodontol.* 2018;89 Suppl 1:S313-S318.
11. Dreyer H, Grischke J, Tiede C, Eberhard J, Schweitzer A, Toikkanen SE, Glöckner S, Krause G, Stiesch M. Epidemiology and risk factors of peri-implantitis: A systematic review. *J Periodontal Res.* 2018 Oct;53(5):657-681. doi: 10.1111/jre.12562. Epub 2018 Jun 7. PMID: 29882313.

Etiology and risk factors:

1. Strietzel FP, Reichart PA, Kale A, Kulkarni M, Wegner B, Küchler I. Smoking interferes with the prognosis of dental implant treatment: a systematic review and meta-analysis. *J Clin Periodontol.* 2007 Jun;34(6):523-44. doi: 10.1111/j.1600-051X.2007.01083.x. PMID: 17509093.
2. Zitzmann NU, Berglundh T. Definition and prevalence of peri-implant diseases. *J Clin Periodontol.* 2008 Sep;35(8 Suppl):286-91. doi: 10.1111/j.1600-051X.2008.01274.x. PMID: 18724856.

3. Monje A, Aranda L, Diaz KT, et al. Impact of Maintenance Therapy for the Prevention of Peri-implant Diseases: A Systematic Review and Meta-analysis. *J Dent Res.* 2016;95:372-379.
4. Monje A, Catena A, Borgnakke WS. Association between diabetes mellitus/hyperglycaemia and peri-implant diseases: Systematic review and meta-analysis. *J Clin Periodontol.* 2017;44:636-648.
5. Albrektsson T, Chrcanovic B, Ostman PO, Sennerby L. Initial and long-term crestal bone responses to modern dental implants. *Periodontol 2000.* 2017;73:41-50.
6. Chappuis V, Avila-Ortiz G, Araujo MG, Monje A. Medication-related dental implant failure: Systematic review and meta-analysis. *Clin Oral Implants Res.* 2018;29 Suppl 16:55-68.
7. Thoma DS, Naenni N, Figuero E, et al. Effects of soft tissue augmentation procedures on peri-implant health or disease: A systematic review and meta-analysis. *Clin Oral Implants Res.* 2018;29 Suppl 15:32-49.
8. Naseri R, Yaghini J, Feizi A. Levels of smoking and dental implants failure: A systematic review and meta-analysis. *J Clin Periodontol.* 2020;47:518-528.

Microbiology:

1. Heitz-Mayfield LJ, Lang NP. Comparative biology of chronic and aggressive periodontitis vs. peri-implantitis. *Periodontol 2000.* 2010;53:167-181.
2. Lafaurie GI, Sabogal MA, Castillo DM, et al. Microbiome and Microbial Biofilm Profiles of Peri-Implantitis: A Systematic Review. *J Periodontol.* 2017;88:1066-1089.

2017 World Workshop

1. Papapanou PN, Sanz M, Buduneli N, et al. Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Periodontol.* 2018 Jun;89 Suppl 1:S173-S182. doi: 10.1002/JPER.17-0721. PMID: 29926951.
2. Jepsen S, Caton JG, Albandar JM, et al. Periodontal manifestations of systemic diseases and developmental and acquired conditions: Consensus report of workgroup 3 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Periodontol.* 2018 Jun;89 Suppl 1:S237-S248. doi: 10.1002/JPER.17-0733. PMID: 29926943.
3. Papapanou PN, Sanz M, Buduneli N, et al. Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Clin Periodontol.* 2018 Jun;45 Suppl 20:S162-S170. doi: 10.1111/jcpe.12946. PMID: 29926490.

23. Management of peri implant mucositis and peri-implantitis

Questions to be answered towards the end of this seminar

- Does non-surgical management help with management of peri implant mucositis and peri implantitis?
- What are the various tools used for non-surgical debridement and how do they compare with each other?
- How can an implant be decontaminated? How do these modes compare with respect to efficacy of decontamination?
- How can you classify the severity of the peri-implantitis?
- What is the most common form of defect morphology seen in peri-implantitis?
- What type of defects are amenable to resective surgery?
- What is the effect of implantoplasty?
- What type of defects are amenable to regenerative therapy?
- What is the success of implants in reimplantation sites?
- What is the long-term outcome of implants treated with various methods for peri-implantitis?

23.1 Peri-implant mucositis and peri-implantitis: non-surgical management

1. Schwarz F, Becker K, Renvert S. Efficacy of air polishing for the non-surgical treatment of peri-implant diseases: a systematic review. *J Clin Periodontol.* 2015 Oct;42(10):951-9. doi: 10.1111/jcpe.12454. Epub 2015 Oct 16. PMID: 26362615.
2. Renvert S, Samuelsson E, Lindahl C, Persson GR. Mechanical non-surgical treatment of peri-implantitis: a double-blind randomized longitudinal clinical study. I: clinical results. *J Clin Periodontol.* 2009 Jul;36(7):604-9. doi: 10.1111/j.1600-051X.2009.01421.x. Erratum in: *J Clin Periodontol.* 2009 Dec;36(12):1076. PMID: 19538334.
3. Serino G, Strom C. Peri-implantitis in partially edentulous patients: association with inadequate plaque control. *Clin Oral Implants Res* 2009;20:169-174. doi: 10.1111/j.1600-0501.2008.01627.x.
4. Riben-Grundstrom C, Norderyd O, André U, Renvert S. Treatment of peri-implant mucositis using a glycine powder air-polishing or ultrasonic device: a randomized clinical trial. *J Clin Periodontol.* 2015 May;42(5):462-9. doi: 10.1111/jcpe.12395. Epub 2015 Apr 30. PMID: 25851433.
5. Hallström H, Persson GR, Lindgren S, Olofsson M, Renvert S. Systemic antibiotics and debridement of peri-implant mucositis. A randomized clinical trial. *J Clin Periodontol.* 2012 Jun;39(6):574-81. doi: 10.1111/j.1600-051X.2012.01884.x. PMID: 22571225.
6. Sahm N, Becker J, Santel T, Schwarz F. Non-surgical treatment of peri-implantitis using an air-abrasive device or mechanical debridement and local application of chlorhexidine: a prospective, randomized, controlled clinical study. *J Clin Periodontol.* 2011 Sep;38(9):872-8. doi: 10.1111/j.1600-051X.2011.01762.x. Epub 2011 Jul 19. PMID: 21770995.
7. Blasi A, Iorio-Siciliano V, Pacenza C, Pomingi F, Matarasso S, Rasperini G. Biofilm removal from implants supported restoration using different instruments: a 6-month comparative multicenter clinical study. *Clin Oral Implants Res.* 2016 Feb;27(2):e68-73. doi: 10.1111/clr.12530. Epub 2014 Dec 11. PMID: 25496020.
8. Gennai S, Bollain J, Ambrosio N, Marruganti C, Graziani F, Figuero E. Efficacy of adjunctive measures in peri-implant mucositis. A systematic review and meta-analysis. *J Clin Periodontol.* 2023 Jun;50 Suppl 26:161-187. doi: 10.1111/jcpe.13791. Epub 2023 Mar 6. PMID: 36792063.
9. Renvert S, Roos-Jansåker AM, Claffey N. Non-surgical treatment of peri-implant mucositis and peri-implantitis: a literature review. *J Clin Periodontol.* 2008 Sep;35(8 Suppl):305-15. doi: 10.1111/j.1600-051X.2008.01276.x. PMID: 18724858.
10. Salvi GE, Ramseier CA. Efficacy of patient-administered mechanical and/or chemical plaque control protocols in the management of peri-implant mucositis. A systematic review. *J Clin Periodontol.* 2015 Apr;42 Suppl 16:S187-201. doi: 10.1111/jcpe.12321. PMID: 25495416.
11. Renvert S, Hirooka H, Polyzois I, Kelekis-Cholakis A, Wang HL; Working Group 3. Diagnosis and non-surgical treatment of peri-implant diseases and maintenance care of patients with dental implants - Consensus report of working group 3. *Int Dent J.* 2019 Sep;69(Suppl 2):12-17. doi: 10.1111/idj.12490. PMID: 31478575; PMCID: PMC9379037.
12. Jepsen S, Berglundh T, Genco R, Aass AM, Demirel K, Derkx J, Figuero E, Giovannoli JL, Goldstein M, Lambert F, Ortiz-Vigon A, Polyzois I, Salvi GE, Schwarz F, Serino G, Tomasi C, Zitzmann NU. Primary prevention of peri-implantitis: managing peri-implant mucositis. *J Clin Periodontol.* 2015 Apr;42 Suppl 16:S152-7. doi: 10.1111/jcpe.12369. PMID: 25626479.
13. Suárez-López Del Amo F, Yu SH, Wang HL. Non-Surgical Therapy for Peri-Implant Diseases: a Systematic Review. *J Oral Maxillofac Res.* 2016 Sep 9;7(3):e13. doi: 10.5037/jomr.2016.7313. PMID: 27833738; PMCID: PMC5100638.

14. Maeda T, Mukaibo T, Masaki C, Thongpoung S, Tsuka S, Tamura A, Aonuma F, Kondo Y, Hosokawa R. Efficacy of electric-powered cleaning instruments in edentulous patients with implant-supported full-arch fixed prostheses: a crossover design. *Int J Implant Dent.* 2019 Mar 26;5(1):7. doi: 10.1186/s40729-019-0164-8. PMID: 30911853; PMCID: PMC6434005.
15. Iorio-Siciliano V, Blasi A, Isola G, Sculean A, Salvi GE, Ramaglia L. Resolution of peri-implant mucositis at tissue- and bone-level implants: A 6-month prospective controlled clinical trial. *Clin Oral Implants Res.* 2023 May;34(5):450-462. doi: 10.1111/clr.14051. Epub 2023 Mar 2. PMID: 36807939.
16. Herrera D, Berglundh T, Schwarz F, Chapple I, Jepsen S, Sculean A, Kebschull M, Papapanou PN, Tonetti MS, Sanz M; EFP workshop participants and methodological consultant. Prevention and treatment of peri-implant diseases-The EFP S3 level clinical practice guideline. *J Clin Periodontol.* 2023 Jun;50 Suppl 26:4-76. doi: 10.1111/jcpe.13823. Epub 2023 Jun 4. PMID: 37271498.

23.2 *Implant surface decontamination*

1. Dennison DK, Huerzeler MB, Quinones C, Caffesse RG. Contaminated implant surfaces: an in vitro comparison of implant surface coating and treatment modalities for decontamination. *J Periodontol.* 1994 Oct;65(10):942-8. doi: 10.1902/jop.1994.65.10.942. PMID: 7823276.
2. Keim D, Nickles K, Dannowitz B, Ratka C, Eickholz P, Petsos H. In vitro efficacy of three different implant surface decontamination methods in three different defect configurations. *Clin Oral Implants Res.* 2019 Jun;30(6):550-558. doi: 10.1111/clr.13441. Epub 2019 May 8. PMID: 31009116.
3. Matsubara VH, Leong BW, Leong MJL, Lawrence Z, Becker T, Quaranta A. Cleaning potential of different air abrasive powders and their impact on implant surface roughness. *Clin Implant Dent Relat Res.* 2020 Feb;22(1):96-104. doi: 10.1111/cid.12875. Epub 2019 Dec 13. PMID: 31837107.
4. Ichioka Y, Derks J, Dahlén G, Berglundh T, Larsson L. Mechanical removal of biofilm on titanium discs: An in vitro study. *J Biomed Mater Res B Appl Biomater.* 2022 May;110(5):1044-1055. doi: 10.1002/jbm.b.34978. Epub 2021 Dec 13. PMID: 34897974.
5. Ichioka Y, Virtö L, Nuevo P, Gamonal JD, Derks J, Larsson L, Sanz M, Berglundh T. Decontamination of biofilm-contaminated implant surfaces: An in vitro evaluation. *Clin Oral Implants Res.* 2023 Jul 20. doi: 10.1111/clr.14136. Epub ahead of print. PMID: 37469250.
6. Schwarz F, Sahm N, Iglhaut G, Becker J. Impact of the method of surface debridement and decontamination on the clinical outcome following combined surgical therapy of peri-implantitis: a randomized controlled clinical study. *J Clin Periodontol.* 2011 Mar;38(3):276-84. doi: 10.1111/j.1600-051X.2010.01690.x. Epub 2011 Jan 11. PMID: 21219392.
7. de Waal YC, Raghoobar GM, Huddleston Slater JJ, Meijer HJ, Winkel EG, van Winkelhoff AJ. Implant decontamination during surgical peri-implantitis treatment: a randomized, double-blind, placebo-controlled trial. *J Clin Periodontol.* 2013 Feb;40(2):186-95. doi: 10.1111/jcpe.12034. Epub 2012 Dec 4. Erratum in: *J Clin Periodontol.* 2014 Jan;41(1):94. PMID: 23211012.
8. Hentenaar DFM, De Waal YCM, Strooker H, Meijer HJA, Van Winkelhoff AJ, Raghoobar GM. Implant decontamination with phosphoric acid during surgical peri-implantitis treatment: a RCT. *Int J Implant Dent.* 2017 Dec;3(1):33. doi: 10.1186/s40729-017-0091-5. Epub 2017 Jul 17. PMID: 28718012; PMCID: PMC5514004.
9. de Tapia B, Valles C, Ribeiro-Amaral T, Mor C, Herrera D, Sanz M, Nart J. The adjunctive effect of a titanium brush in implant surface decontamination at peri-implantitis surgical regenerative interventions: A

- randomized controlled clinical trial. *J Clin Periodontol.* 2019 May;46(5):586-596. doi: 10.1111/jcpe.13095. Epub 2019 Apr 22. PMID: 30825341.
10. Louropoulou A, Slot DE, Van der Weijden FA. Titanium surface alterations following the use of different mechanical instruments: a systematic review. *Clin Oral Implants Res.* 2012 Jun;23(6):643-658. doi: 10.1111/j.1600-0501.2011.02208.x. Epub 2011 May 12. PMID: 21564303.
 11. Koo KT, Khouri F, Keeve PL, Schwarz F, Ramanauskaite A, Sculean A, Romanos G. Implant Surface Decontamination by Surgical Treatment of Periimplantitis: A Literature Review. *Implant Dent.* 2019 Apr;28(2):173-176. doi: 10.1097/ID.0000000000000840. PMID: 30767944.
 12. Francis S, Iaculli F, Perrotti V, Piattelli A, Quaranta A. Titanium Surface Decontamination: A Systematic Review of In Vitro Comparative Studies. *Int J Oral Maxillofac Implants.* 2022 Jan-Feb;37(1):76-84. doi: 10.11607/jomi.8969. PMID: 35235623.
 13. Cosgarea R, Rocuzzo A, Jepsen K, Sculean A, Jepsen S, Salvi GE. Efficacy of mechanical/physical approaches for implant surface decontamination in non-surgical submarginal instrumentation of peri-implantitis. A systematic review. *J Clin Periodontol.* 2023 Jun;50 Suppl 26:188-211. doi: 10.1111/jcpe.13762. Epub 2023 Jan 23. PMID: 36550060.
 14. Wilensky A, Shapira L, Limones A, Martin C. The efficacy of implant surface decontamination using chemicals during surgical treatment of peri-implantitis: A systematic review and meta-analysis. *J Clin Periodontol.* 2023 Jun;50 Suppl 26:336-358. doi: 10.1111/jcpe.13794. Epub 2023 Mar 12. PMID: 36792071.

23.3 Peri-implantitis defect and treatment planning

1. Schwarz F, Sahm N, Schwarz K, Becker J. Impact of defect configuration on the clinical outcome following surgical regenerative therapy of peri-implantitis. *J Clin Periodontol.* 2010 May;37(5):449-55. doi: 10.1111/j.1600-051X.2010.01540.x. Epub 2010 Mar 24. PMID: 20374416.
2. Froum SJ, Rosen PS. A proposed classification for peri-implantitis. *Int J Periodontics Restorative Dent.* 2012 Oct;32(5):533-40. PMID: 22754901.
3. Sinjab K, Garaicoa-Pazmino C, Wang HL. Decision Making for Management of Periimplant Diseases. *Implant Dent.* 2018 Jun;27(3):276-281. doi: 10.1097/ID.0000000000000775. PMID: 29762186.
4. Monje A, Pons R, Insua A, Nart J, Wang HL, Schwarz F. Morphology and severity of peri-implantitis bone defects. *Clin Implant Dent Relat Res.* 2019 Aug;21(4):635-643. doi: 10.1111/cid.12791. Epub 2019 May 14. PMID: 31087457.

23.4 Surgical management and outcomes

1. Romeo E, Lops D, Chiapasco M, Ghisolfi M, Vogel G. Therapy of peri-implantitis with resective surgery. A 3-year clinical trial on rough screw-shaped oral implants. Part II: radiographic outcome. *Clin Oral Implants Res.* 2007 Apr;18(2):179-87. doi: 10.1111/j.1600-0501.2006.01318.x. PMID: 17348882.
2. Englezos E, Cosyn J, Koole S, Jacquet W, De Bruyn H. Resective Treatment of Peri-implantitis: Clinical and Radiographic Outcomes After 2 Years. *Int J Periodontics Restorative Dent.* 2018 Sep/Oct;38(5):729-735. doi: 10.11607/prd.3386. PMID: 30113610.
3. Heitz-Mayfield LJ, Mombelli A. The therapy of peri-implantitis: a systematic review. *Int J Oral Maxillofac Implants.* 2014;29 Suppl:325-45. doi: 10.11607/jomi.2014suppl.g5.3. PMID: 24660207.

4. Schwarz F, Hegewald A, John G, Sahm N, Becker J. Four-year follow-up of combined surgical therapy of advanced peri-implantitis evaluating two methods of surface decontamination. *J Clin Periodontol.* 2013 Oct;40(10):962-7. doi: 10.1111/jcpe.12143. Epub 2013 Aug 12. PMID: 23931259.
5. Schwarz F, John G, Schmucker A, Sahm N, Becker J. Combined surgical therapy of advanced peri-implantitis evaluating two methods of surface decontamination: a 7-year follow-up observation. *J Clin Periodontol.* 2017 Mar;44(3):337-342. doi: 10.1111/jcpe.12648. Epub 2017 Jan 19. PMID: 28101947.
6. Schwarz F, Jepsen S, Obreja K, Galarraga-Vinueza ME, Ramanauskaite A. Surgical therapy of peri-implantitis. *Periodontol 2000.* 2022 Feb;88(1):145-181. doi: 10.1111/prd.12417. PMID: 35103328.
7. Ramanauskaite A, Cafferata EA, Begic A, Schwarz F. Surgical interventions for the treatment of peri-implantitis. *Clin Implant Dent Relat Res.* 2023 Aug;25(4):682-695. doi: 10.1111/cid.13162. Epub 2022 Nov 23. PMID: 36419243.
8. Hürzeler MB, Quiñones CR, Morrison EC, Caffesse RG. Treatment of peri-implantitis using guided bone regeneration and bone grafts, alone or in combination, in beagle dogs. Part 1: Clinical findings and histologic observations. *Int J Oral Maxillofac Implants.* 1995 Jul-Aug;10(4):474-84. PMID: 7672851.
9. Froum SJ, Froum SH, Rosen PS. Successful management of peri-implantitis with a regenerative approach: a consecutive series of 51 treated implants with 3- to 7.5-year follow-up. *Int J Periodontics Restorative Dent.* 2012 Feb;32(1):11-20. PMID: 22254219.
10. Froum SJ, Froum SH, Rosen PS. A Regenerative Approach to the Successful Treatment of Peri-implantitis: A Consecutive Series of 170 Implants in 100 Patients with 2- to 10-Year Follow-up. *Int J Periodontics Restorative Dent.* 2015 Nov-Dec;35(6):857-63. doi: 10.11607/prd.2571. PMID: 26509990.
11. Claffey N, Clarke E, Polyzois I, Renvert S. Surgical treatment of peri-implantitis. *J Clin Periodontol.* 2008 Sep;35(8 Suppl):316-32. doi: 10.1111/j.1600-051X.2008.01277.x. PMID: 18724859.
12. Esposito M, Grusovin MG, Worthington HV. Treatment of peri-implantitis: what interventions are effective? A Cochrane systematic review. *Eur J Oral Implantol.* 2012;5 Suppl:S21-41. PMID: 22834392.
13. Chan HL, Lin GH, Suarez F, MacEachern M, Wang HL. Surgical management of peri-implantitis: a systematic review and meta-analysis of treatment outcomes. *J Periodontol.* 2014 Aug;85(8):1027-41. doi: 10.1902/jop.2013.130563. Epub 2013 Nov 21. PMID: 24261909.
14. Heitz-Mayfield LJA, Salvi GE, Mombelli A, Loup PJ, Heitz F, Kruger E, Lang NP. Supportive peri-implant therapy following anti-infective surgical peri-implantitis treatment: 5-year survival and success. *Clin Oral Implants Res.* 2018 Jan;29(1):1-6. doi: 10.1111/clr.12910. Epub 2016 Jun 23. PMID: 27335316.
15. Khoury F, Keeve PL, Ramanauskaite A, Schwarz F, Koo KT, Sculean A, Romanos G. Surgical treatment of peri-implantitis - Consensus report of working group 4. *Int Dent J.* 2019 Sep;69 Suppl 2(Suppl 2):18-22. doi: 10.1111/idj.12505. PMID: 31478576; PMCID: PMC9379045.
16. Bianchini MA, Galarraga-Vinueza ME, Apaza-Bedoya K, De Souza JM, Magini R, Schwarz F. Two to six-year disease resolution and marginal bone stability rates of a modified resective-implantoplasty therapy in 32 peri-implantitis cases. *Clin Implant Dent Relat Res.* 2019 Aug;21(4):758-765. doi: 10.1111/cid.12773. Epub 2019 Apr 15. PMID: 30985073.
17. Carcuac O, Derks J, Abrahamsson I, Wennström JL, Berglundh T. Risk for recurrence of disease following surgical therapy of peri-implantitis-A prospective longitudinal study. *Clin Oral Implants Res.* 2020 Nov;31(11):1072-1077. doi: 10.1111/clr.13653. Epub 2020 Sep 14. PMID: 32870513.

18. Ramanauskaitė A, Becker K, Cafferata EA, Schwarz F. Clinical efficacy of guided bone regeneration in peri-implantitis defects. A network meta-analysis. *Periodontol 2000*. 2023 Jul 25. doi: 10.1111/prd.12510. Epub ahead of print. PMID: 37490412.

23.5 Explantation and re-implantation

1. Greenstein G, Cavallaro J. Failed dental implants: diagnosis, removal and survival of reimplantations. *J Am Dent Assoc*. 2014 Aug;145(8):835-42. doi: 10.14219/jada.2014.28. PMID: 25082932.
2. Stajčić Z, Stojčev Stajčić LJ, Kalanović M, Đinić A, Divekar N, Rodić M. Removal of dental implants: review of five different techniques. *Int J Oral Maxillofac Surg*. 2016 May;45(5):641-8. doi: 10.1016/j.ijom.2015.11.003. Epub 2015 Dec 10. PMID: 26688293.
3. Solderer A, Al-Jazrawi A, Sahrmann P, Jung R, Attin T, Schmidlin PR. Removal of failed dental implants revisited: Questions and answers. *Clin Exp Dent Res*. 2019 Aug 21;5(6):712-724. doi: 10.1002/cre2.234. PMID: 31890309; PMCID: PMC6934347.
4. Roy M, Loutan L, Garavaglia G, Hashim D. Removal of osseointegrated dental implants: a systematic review of explantation techniques. *Clin Oral Investig*. 2020 Jan;24(1):47-60. doi: 10.1007/s00784-019-03127-0. Epub 2019 Nov 15. PMID: 31729576.
5. Machtei EE, Mahler D, Oettinger-Barak O, Zuabi O, Horwitz J. Dental implants placed in previously failed sites: survival rate and factors affecting the outcome. *Clin Oral Implants Res*. 2008 Mar;19(3):259-64. doi: 10.1111/j.1600-0501.2007.01466.x. Epub 2008 Jan 3. PMID: 18177430.
6. Chrcanovic BR, Kisch J, Albrektsson T, Wennerberg A. Survival of dental implants placed in sites of previously failed implants. *Clin Oral Implants Res*. 2017 Nov;28(11):1348-1353. doi: 10.1111/clr.12992. Epub 2016 Oct 14. PMID: 27743398.
7. Anitua E, Montalvillo A, Eguia A, Alkhraisat MH. Clinical outcomes of dental implants placed in the same region where previous implants failed due to peri-implantitis: a retrospective study. *Int J Implant Dent*. 2021 Nov 9;7(1):109. doi: 10.1186/s40729-021-00392-1. PMID: 34751830; PMCID: PMC8578225.
8. Monje A, Nart J. Management and sequelae of dental implant removal. *Periodontol 2000*. 2022 Feb;88(1):182-200. doi: 10.1111/prd.12418. PMID: 35103326.
9. Machtei EE, Horwitz J, Mahler D, Grossmann Y, Levin L. Third attempt to place implants in sites where previous surgeries have failed. *J Clin Periodontol*. 2011 Feb;38(2):195-8. doi: 10.1111/j.1600-051X.2010.01629.x. Epub 2010 Oct 19. PMID: 20958341.

23.6 Treatment of peri-implant mucositis and peri-implantitis with lasers

Er,Cr,YSGG

Kang P, Sanz-Miralles E, Li J, Linden E, Momen-Heravi F. Efficacy of Er,Cr:YSGG Laser Application in Nonsurgical Treatment of Peri-implantitis: A Human Randomized Controlled Trial. *Int J Periodontics Restorative Dent*. 2023 Jan-Feb;43(1):e1-e9. doi: 10.11607/prd.6384. PMID: 36661870.

Nd:YAG

Dortaj D, Bassir SH, Hakimiha N, Hong H, Aslroosta H, Fekrazad R, Moslemi N. Efficacy of Nd:YAG laser-assisted periodontal therapy for the management of periodontitis: A double-blind split-mouth randomized controlled clinical trial. *J Periodontol*. 2022 May;93(5):662-672. doi: 10.1002/JPER.21-150

0242. Epub 2021 Sep 12. PMID: 34411291.

Reviews:

1. Chambrone L, Wang HL, Romanos GE. Antimicrobial photodynamic therapy for the treatment of periodontitis and peri-implantitis: An American Academy of Periodontology best evidence review. *J Periodontol*. 2018 Jul;89(7):783-803. doi: 10.1902/jop.2017.170172. PMID: 30133749.
2. Lin GH, Suárez López Del Amo F, Wang HL. Laser therapy for treatment of peri-implant mucositis and peri-implantitis: An American Academy of Periodontology best evidence review. *J Periodontol*. 2018 Jul;89(7):766-782. doi: 10.1902/jop.2017.160483. PMID: 30133748.
3. Mills MP, Rosen PS, Chambrone L, et al. American Academy of Periodontology best evidence consensus statement on the efficacy of laser therapy used alone or as an adjunct to non-surgical and surgical treatment of periodontitis and peri-implant diseases. *J Periodontol*. 2018 Jul;89(7):737-742. doi: 10.1002/JPER.17-0356. PMID: 29693260.

24. *Implant Maintenance*

Questions to be answered from this topic:

- Why is maintenance therapy necessary?
- What is the importance of patient compliance in maintaining implants?
- What are the results of when patients are not maintained?
- What is the ideal maintenance frequency?
- How can one manage full-arch prosthesis?

1. Serino G, Ström C. Peri-implantitis in partially edentulous patients: association with inadequate plaque control. *Clin Oral Implants Res*. 2009 Feb;20(2):169-74. doi: 10.1111/j.1600-0501.2008.01627.x. Epub 2008 Dec 1. PMID: 19077152.\
2. Cardaropoli D, Gaveglia L. Supportive periodontal therapy and dental implants: an analysis of patients' compliance. *Clin Oral Implants Res*. 2012 Dec;23(12):1385-8. doi: 10.1111/j.1600-0501.2011.02316.x. Epub 2011 Oct 21. PMID: 22092745.
3. Costa FO, Takenaka-Martinez S, Cota LO, Ferreira SD, Silva GL, Costa JE. Peri-implant disease in subjects with and without preventive maintenance: a 5-year follow-up. *J Clin Periodontol*. 2012 Feb;39(2):173-81. doi: 10.1111/j.1600-051X.2011.01819.x. Epub 2011 Nov 23. PMID: 22111654.
4. Pjetursson BE, Helbling C, Weber HP, Matuliene G, Salvi GE, Brägger U, Schmidlin K, Zwahlen M, Lang NP. Peri-implantitis susceptibility as it relates to periodontal therapy and supportive care. *Clin Oral Implants Res*. 2012 Jul;23(7):888-94. doi: 10.1111/j.1600-0501.2012.02474.x. Epub 2012 Apr 24. Erratum in: *Clin Oral Implants Res*. 2012 Aug;23(8):1004. PMID: 22530771.
5. Monje A, Wang HL, Nart J. Association of Preventive Maintenance Therapy Compliance and Peri-Implant Diseases: A Cross-Sectional Study. *J Periodontol*. 2017 Oct;88(10):1030-1041. doi: 10.1902/jop.2017.170135. Epub 2017 May 26. PMID: 28548886.
6. Tan WC, Ong MM, Lang NP. Influence of maintenance care in periodontally susceptible and non-susceptible subjects following implant therapy. *Clin Oral Implants Res*. 2017 Apr;28(4):491-494. doi: 10.1111/clr.12824. Epub 2016 Mar 19. PMID: 26992439.

Review:

7. Meffert, R. M., Langer, B., & Fritz, M. E. (1992). Dental implants: a review. *Journal of periodontology*, 63(11), 859–870. <https://doi.org/10.1902/jop.1992.63.11.859>

8. Mombelli A. (2019). Maintenance therapy for teeth and implants. *Periodontology 2000*, 79(1), 190–199. <https://doi.org/10.1111/prd.12255>
9. Cortellini S, Favril C, De Nutte M, Teughels W, Quirynen M. Patient compliance as a risk factor for the outcome of implant treatment. *Periodontol 2000* 2019;81:209-225. doi: 10.1111/prd.12293.