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Feature Article

Molars

Therapeutic Choices in the Molar Region

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abstract

Treatment of the damaged molar often presents a set of challenges unique to the posterior dentition. Traditional dental treatments continue to be refined to improve the prognosis when treating the posterior dentition. Daily treatment-planning decisions include whether to treat with conventional dental or implant therapeutic approaches, and involve consideration of local host factors as well as limitations in specific therapeutic approaches. This article will review some of the factors to consider in these treatment-planning decisions.

Treatment of the damaged molar often presents a set of challenges unique to the posterior dentition, given the presence of furcations, root proximities, and the maxillary sinus. Traditional dental treatments, including endodontic and periodontal treatment modalities, continue to be refined to improve the prognosis when treating the posterior dentition. Advances in surgical techniques, magnification, and materials to enhance healing responses are increasing the predictability of a positive outcome. At the same time, dental implant therapies are providing return of form, function, and esthetics to the patient with the damaged dentition. Daily treatment-planning decisions include whether to treat with conventional dental or implant therapeutic approaches, and involve consideration of local host factors as well as limitations in specific therapeutic approaches. This article will review some of the factors to consider in these treatment-planning decisions.

Clinical Crown-Lengthening Procedures

Restoration of a tooth exhibiting subgingival caries, fracture, or resorptive lesions may necessitate a combination of periodontal, endodontic, orthodontic, and restorative treatments. Clinical crown-lengthening surgery is often performed to expose the apical extent of caries or a fracture, or to place an area of cervical external root resorption above the marginal gingiva.

The concept of clinical crown lengthening is based in part on the findings of Gargiulo and colleagues in 1961.[1] Human autopsy specimens were evaluated histologically to determine the dimensions of the periodontal structures associated with the natural dentition. Average measurements of 0.97 mm of epithelial attachment and 1.07 mm of connective tissue attachment to the root surface were noted with a mean sulcus depth of 0.69 mm. While there were variations in all measurements, these mean measurements form the basis for the concept of the biologic width of attachment. Violation of this width of attachment apparatus by restorative treatment efforts can induce an inflammatory reaction with subsequent loss of crestal bone and connective tissue as well as migration apically of the epithelial attachment.[2-4]

Surgical clinical crown-lengthening procedures ideally establish a cavo-surface to crestal bone distance of 3 mm[5] to 5 mm,[6] and animal studies indicate that the biologic width of attachment is re-established with epithelial and connective tissue attachment to the root surface during the healing and tissue maturation process[7] (**Figures 1 through 5**).

Surgical clinical crown-lengthening procedures do, however, remove supporting crestal bone. The anticipated remaining osseous support should be determined preoperatively as well as preoperative mobility patterns. Root forms play a role in this determination. Long, broad root forms with parallel walls generally have a better prognosis than short, conical roots. Furcation position on molar teeth in need of crown lengthening or on molar teeth adjacent to premolar teeth in need of crown lengthening procedures will also be a factor. In general, molars with moderate to long root trunk and divergent root forms (**Figure 6**) are more favorable candidates for these surgical procedures than are those teeth with short root trunks or convergent root patterns (**Figure 7**). Caries, fracture, or resorptive lesion proximity to a furcation opening can weigh negatively on the decision to attempt to retain the tooth in question. Surgical crown lengthening in molars with a short root trunk can lead to horizontal furcation involvement, downgrading the long-term prognosis for the tooth, particularly in periodontally sensitive individuals. Preoperative mobility patterns are also a consideration. Recurrent caries in the xerostomic patient may also increase the likelihood of intermediate or long-term failure (**Table 1**).

Clinical crown-lengthening procedures may also be indicated in the management of external resorptive lesions. Root resorption may be secondary to damage to the periodontal ligament through acute trauma or endodontic, orthodontic, pedodontic or periodontal procedures.[8] Internal bleaching procedures of pulpless teeth may also be responsible for initiating a resorptive response, [9] however, these procedures are rarely performed in posterior teeth.

Furcation Management

Molar and premolar teeth exhibiting furcation involvement present some of the greatest challenges to successful dental treatment. Various classification schemes have been developed in an effort to describe the degree of involvement, with descriptions of grade or class based generally on the degree of horizontal furcation involvement. Glickman[10] described four grades of furcation involvement (**Table 2**), with other classifications through time further defining his grade II lesion.[11,12]

The horizontal and vertical component of the furcally involved tooth will be one of the greatest determinants of successful professional instrumentation and surgical therapy, however additional contributing anatomic factors also play a role. Furcation entrance width, root trunk length and the presence of root concavities, cervical enamel projections, and enamel pearls have all been cited as prognostic indicators.[13] The width of the furcation entrance was evaluated by Bower,[14] with the majority of entrances measuring less than 0.75 mm. Difficulties are then encountered in thorough root preparation with hand instrumentation in these sites, as the average width of the curette blades is wider than this distance. The presence of cervical enamel projections and enamel pearls prevents connective tissue attachment to these areas[15] and complicates the management of the furcation lesion.

Endodontic and periodontal interrelationships also play a role in the management of the furcation region. Pulpal necrosis and lesions of endodontic origin often lead to destruction of the periapical alveolar bone, and if undiagnosed or untreated, can progress through the periodontal ligament and present as localized loss of clinical attachment. This commonly would present as a narrow, deep localized probing defect leading to the area of primary destruction. However, in long-standing endo-perio lesions and in cases of root proximity, they can present as broad deep pockets and extend in a tortuous course (**Figures 8 through 10**). The presence of accessory or furcation canals has been noted in from 23 percent [16] to 76 percent[17] of molars studied, and studies have confirmed that pulpal inflammation will induce an inflammatory condition in the interradicular area.[18,19] The pulpal status of the tooth needs to be diagnosed when there is furcation involvement, and endodontic therapy initiated if indicated. The furcation lesion will often repair, with successful endodontic therapy, if the damage is due to pulpal necrosis.

Surgical treatment of the furcation-involved molars has targeted increased access for home care and preventive maintenance visits (pocket elimination surgery, tunneling procedures, and root resection) or has been directed at efforts to regain lost clinical attachment through grafting materials, guided tissue procedures, or regenerative proteins. Many studies have been performed to evaluate efficacy of various treatment modalities. Wang studied the effects of various surgical approaches and noted that molars with furcation involvement were 2.5 times more likely to be lost during the eight-year study period.[20]

Many studies have evaluated the long-term effectiveness of root resection procedures in preserving the dentition. Langer and colleagues retrospectively evaluated the response of 100 patients to root resection procedures.[21] Thirty-eight percent of the treated teeth were classified as failures during the 10-year observation period, due to bone loss, root fracture, untreatable caries, or endodontic problems. Another 10-year study by Buhler revealed a 32 percent total failure rate in root resected molars.[22] While other investigators report greater successes, a general review of the published results of the root resection studies indicates an average failure rate of 22 percent in those studies covering a period of at least 10 years and without extensive fixed splinting.[23] The successes of this approach commonly were related to proper restoration design, appropriate periodontal therapy, and the successful endodontic treatment of the remaining root(s) (**Figures 11 through 14**).

Techniques aimed at regeneration of lost periodontal support include grafting with synthetic grafting materials, autografts, or allografts. Synthetic materials histologically have been shown to primarily become encapsulated in connective tissue and offer little in terms of regeneration of lost support.[24,25] Autografts can be obtained from osseous coagulum at the time of surgery or from an intraoral or extraoral donor site. Allogenic bone grafts are available from tissue banks, generally as freeze-dried powders or particles. Evidence indicates that significant bone fill beyond that of debridement controls can be expected following bone grafts. Mean defect fill averages approximately 60 percent to 65 percent following use of these materials over several studies.[26]

Guided tissue regenerative procedures have also been widely used to aid in management of the furcation lesion after a series of compartmentalization studies by Melcher. [27] This treatment approach allows for selective cell repopulation of the root surface, which, in turn, determines the type of attachment that forms. Studies aimed at evaluating the response to guided tissue regeneration procedures reveal significant improvements, particularly in mandibular class II furcations, when compared to debridement alone. Improvements in clinical attachment levels generally occur in the vertical rather than the horizontal direction.[28,29] However, complete furcation closure does not generally occur. Results of long-term studies following guided tissues regeneration procedures suggest that the regenerated periodontium is stable over time in patients who are compliant with plaque control and maintenance intervals. Noncompliant patients, where unsatisfactory levels of gingival inflammation persist or reoccur, are at substantial risk for disease reoccurence.[26]

Dental Implant Treatment

Replacement of missing teeth through endosseous titanium dental implant fixtures is an increasingly popular treatment option. Benefits to this type of therapy include increased support for transmission of masticatory forces, absence of carious lesion formation, improved esthetics and predictability. The longest-term data regarding survival and outcomes of implant-retained prostheses deals with the fully edentulous situation, with 20- to 30-year data available. Shorter-term studies have examined success rates of replacing a missing molar tooth with an implant-supported crown restoration (**Figures 15 and 16**). Becker and Becker[30] reported a 95.7 percent success rate with 24 molar implants placed in 22 patients, followed for an average of two years. Balshi [31] reported a similar success rate of 98.6 percent in 47 patients over a three-year evaluation period, and success rates of 96.3 percent were reported by Bahat and Handelsman[32] with a mean loading period of 16 months.

Anatomical limitations play a role in abilities to replace missing molar teeth with implant-supported restorations. Sinus proximity, inferior alveolar nerve position, adjacent tooth roots and degree of buccal-lingual and occlusal-apical ridge resorption patterns define the available bony housing for implant fixture placement. There are many techniques to improve the volume of bone in deficient sites, including autogenous block grafts, particulate grafts with and without regenerative membranes, and biomodifiers and growth factors. The ability to successfully place a dental implant fixture in an ideal position for return of form and function often depends on the practitioner's ability to develop the implant site, either prior to or concurrent with implant fixture placement.

Conclusion

The molar area presents some of the greatest challenges to successful long-term therapy. Over time, many techniques to preserve the damaged molar have been developed that today appear heroic. The approach to this problem is often multifaceted, and the long-term successes are as dependant upon the ongoing periodontal maintenance and plaque control abilities of the patient as on the technical excellence of the therapy provided. The current successes with the single-molar implant-supported restoration look very promising, and this type of approach removes many of the previous determinants of success from the equation. Longer-term studies and patient follow-up will further define the extent to which the single molar implant-supported restoration replaces the more "traditional" therapies in the management of the damaged molar.

References

1. Gargiulo AW, Wentz FM, et al, Dimensions of the dentogingival junction in humans. *J Periodont* 32:261-7, 1961.

2. Newcomb G, The relationship between the location of subgingival crown margins and gingival inflammation. *J Periodont* 45:151-4, 1974.

3. Nevins M, Skurow H, The intracrevicular restorative margin, the biologic width, and the maintenance of the gingival margin. *Int J Periodont Restorative Dent* 4:31-49, 1984.

4. Parma-Benfenati S, Fugazzotto P, et al, The effect of restorative margins on the post-surgical development and nature of the periodontium. Part II. Anatomical considerations. *Int J Periodont Restorative Dent* 6:65-75, 1986.

5. Fugazzotto P, Periodontal restorative interrelationships: The isolated restoration. *J Am Dent Assoc* 110:915-7, 1985.

6. Wagenberg B, Eskow R, et al, Exposing adequate tooth structure for restorative dentistry. *Int J Periodont Restorative Dent* 9:323-31, 1989.

7. Oakley E, Rhyu I, et al, Formation of the biologic width following crown lengthening in nonhuman primates. *Int J Periodont Restorative Dent* 19:529-41, 1999.

8. Andreasen J, External root resorption: Its implication in dental traumatology, pedodontics, periodontics, orthodontics, and endodontics. *Int Dent J* 18:109-18, 1985.

9. Madison S, Walton R, Cervical root resorption following bleaching of endodontically treated teeth. *J Endodon* 16:570-4, 1990.

10. Glickman I, *Clinical Periodontology,* 1st ed. WB Saunders, Philadelphia.

11. Tarnow D, Fletcher P, Classification of the vertical component of furcation involvement.

J Periodontol 55:283-4, 1984.

12. Recchetti P, A furcation classification based upon pulp chamber-furcation relationships and vertical radiographic bone loss. *Int J Periodont Restorative Dent* 2:51, 1982.

13. Al-Shammari K, Kazor C, Wanh H, Molar root anatomy and management of furcation defects. *J Clin Periodontol* 28:730-40, 2001.

14. Bower RC, Furcation morphology relative to periodontal treatment. Furcation entrance architecture. *J Periodontol* 50:23-7, 1979.

15. Carranza F, Jolkovski D, Current status of periodontal therapy for furcation involvement. *Dent Clin N Am*, 35:555-70, 1991.

16. Kirkham D, The location and incidence of accessory pulpal canals in periodontal pockets. *J Am Dent Assoc* 91:353, 1975.

17. Burch J, Hulen S, A study of the presence of accessory foramina and the topography of molar furcations. *Oral Surg Oral Med Oral Path* 38:451, 1974.

18. Seltzer S, Bender I, et al, Pulpitis induced interradicular change in experimental animals. *J Periodontol* 38:124, 1967.

19. Seltzer S, Bender I, et al, The interrelationship of pulp and periodontal disease. *Oral Surg Oral Med Oral Path Oral Radiol Endod* 16:1474, 1963.

20. Wang H, Burgett F, et al, The influence of molar furcation involvement and mobility on future clinical attachment loss. *J Periodontol* 65:25-9, 1994.

21. Langer B, Stein S, Wagenberg B, An evaluation of root resections. A ten-year study. *J Periodontol* 52:719-23, 1981.

22. Buhler H, Evaluation of root resected teeth. Results after 10 years. *J Clin Periodontol* 59:805-10, 1988.

23. Kinsel R, Lamb R, Ho D, The treatment dilemma of the furcated molar: root resection versus single-tooth implant restoration. A literature review. *Int J Oral Maxillofac Implants* 13:322-32, 1998.

24. Sapkos S, The use of Periograf in periodontal defects -- Histologic findings. *J Periodontol* 57:7-13, 1986.

25. Stahl S, Froum S, Human intrabony lesion responses to debridement, porous hydroxyapatite implants and teflon barrier membranes. Seven histologic case reports. *J Clin Periodontol* 18:605-10, 1991.

26. Garrett S, Periodontal regeneration around natural teeth. *Ann Periodontol* 1:621-66, 1996.

27. Melcher A, On the repair potential of periodontal tissues. *J Periodontol* 47:256-60, 1976.

28. Lekovic V, Kenney E, et al, The use of autogenous periosteal grafts as barriers for treatment of class II furcation involvement in lower molars. *J Periodontol* 61:775-80, 1991.

29. Wang H, O'Neal R, et al, Evaluation of an absorbable collagen membrane in treating class II furcation defects. *J Periodontol* 65:1029-36, 1994.

30. Becker W, Becker B, Replacement of maxillary and mandibular molars with single endosseous implant restorations. A retrospective study. *J Prosthethic Dent* 74:51-5, 1995.

31. Balshi T, Hernandez R, et al A comparative study of one implant vs. two replacing a single molar. *Int J Oral Maxillofacial Implants* 11:372-8, 1996.

32. Bahat O, Handelsman M., Use of wide implants and double implants in the posterior jaw: A clinical report. *Int J Oral Maxillofacial Implants* 11:379-86, 1996.

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Table 1. Clinical Crown Lengthening

Factors for Factors against

Caries or fracture greater than 2 mm from furcation entrance Caries or fracture within 2 mm of furcation entrance

Lack of generalized recurrent caries activity Generalized recurrent decay/xerostomia

Long, broad and divergent root forms Short, conical and convergent root forms

Average to long root trunks Short root trunks

Negotiable endodontic canals Untreatable endodontic situation

No mobility Existing mobility

Table 2. Furcation Classifications -- Glickman

Grade I Incipient

Grade II Loss of interradicular bone and pocket formation, but not extending through to the opposite side

Grade III Through and through lesion

Grade IV Through and through lesion with gingival recession, leading to a clearly visible furcation area

Figure Legends

Figure 1. Provisional crown in place tooth #14 (buccal) with biologic width encroachment.

Figure 2. Postoperative view after crown lengthening.

Figure 3. Preoperative X-ray of molar with inadequate clinical crown length for restoration.

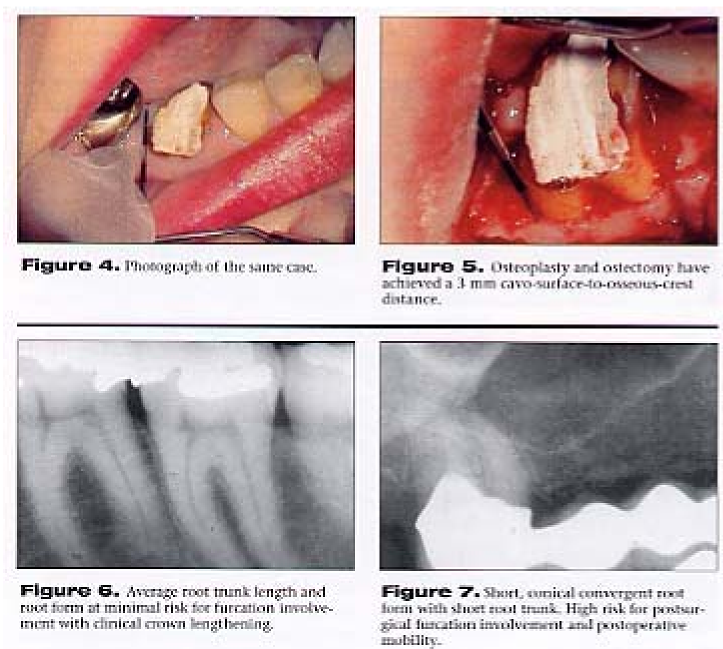

Figure 4. Photograph of the same case.

Figure 5. Osteoplasty and ostectomy have achieved a 3 mm cavo-surface to osseous crest distance.

Figure 6. Average root trunk length and root form at minimal risk for furcation involvement with clinical crown lengthening.

Figure 7. Short, conical convergent root form with short root trunk. High risk for postsurgical furcation involvement and postoperative mobility.

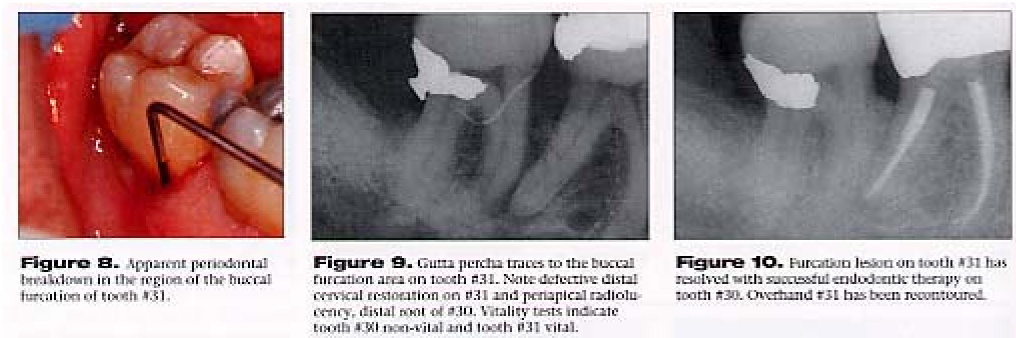

Figure 8. Apparent periodontal breakdown in the region of the buccal furcation tooth #31.

Figure 9. Gutta percha traces to the buccal furcation area on tooth #31. Note defective distal cervical restoration #31 and periapical radiolucency distal root #30. Vitality tests indicate tooth #30 non-vital and tooth #31 vital.

Figure 10. Furcation lesion tooth #31 has resolved with successful endodontic therapy on tooth #30. Overhand #31 has been recontoured.

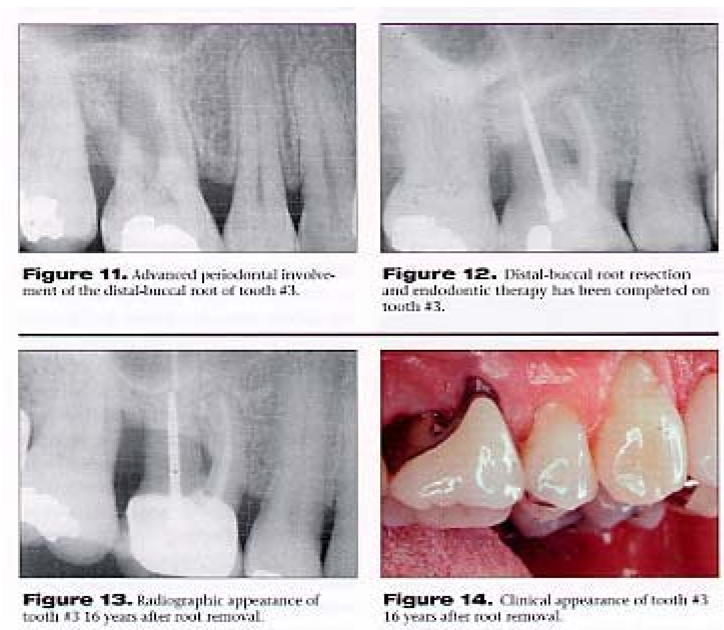

Figure 11. Advanced periodontal involvement of the distal-buccal root of tooth #3.

Figure 12. Distal-buccal root resection and endodontic therapy has been completed on tooth #3.

Figure 13. Radiographic appearance of tooth #3 16 years after root removal.

Figure 14. Clinical appearance of tooth #3 16 years after root removal.

Figure 15. Fractured mandibular first molar and missing second molar.

Figure 16. Missing molars replaced with two ITI implants. This radiograph is 14 months after implant loading (Implant prosthetics by David M. Campbell, DDS).

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