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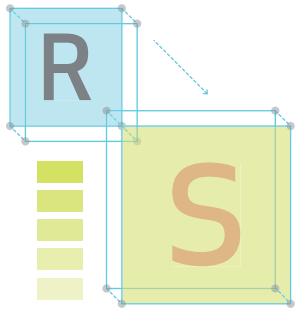

Strategic Extraction: Comparison of Traditional and Implant Therapies

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ABSTRACT According to the evidence-based dentistry principles, the superior treatment options should be pursued. As endosseous dental implants gain greater acceptance, the critical question is whether a tooth with a questionable prognosis should be managed conservatively in a traditional fashion or extracted in preparation for a dental implant. The evidence regarding this issue will be examined in this paper as the outcomes for various treatments are compared.

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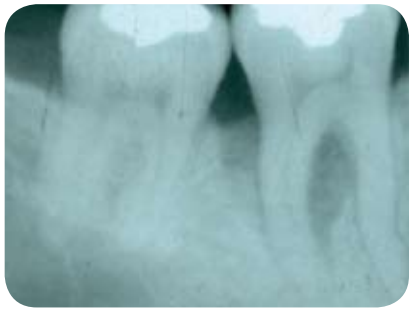
The concept of evidence-based dentistry essentially states that treatment plans should be devised based on the best available evidence from the literature using the experience and wisdom of the practitioner and the needs and desires of the patient. The evidence regarding various treatment strategies needs be compared to fulfill this concept.

Strategic extraction originally described the removal of a tooth or root to create a more hygienic environment.[1,2] The objective was to enhance the status and prognosis of an adjacent tooth or the overall prosthetic treatment plan; that is, eliminate the high-risk element to improve the overall periodontal prosthetic prognosis. Prosthodontists began using the strategy to extract teeth that did not contribute to the removable partial denture design or that compromised the final prosthesis. Orthodontists expanded the tactic to include extracting healthy teeth in crowded dentitions to achieve ideal occlusion. With the acceptance of dental implants, the concept of strategic extraction in preparation for dental implant merits re-examination.

The decision to apply strategic extraction is based on each clinician's prognosis for each individual tooth as well as the overall dentition. Although there is general agreement on the assignment of prognosis, there are subtle differences between practitioners based on decisions as to what tooth or teeth can be successfully treated. These differences are the result of our personal clinical experiences, interpretation of the literature, and techniques at our disposal. With strategic extraction, the prognostic decision process is essentially the weighing of one option against another to determine which offers the best chance of success. As implants become a more accepted treatment, it is important to access their value compared to other treatment modalities.

Selecting implant treatment is essentially a decision to use strategic

extraction, but there have been few articles on this subject.[3-5] This review will examine the concept by comparing the evidence of therapeutic outcomes of placing dental implants as compared to saving teeth with periodontal, prosthetic, and endodontic treatment options.



1A.

1B.

FIGURES 1A-B. Radiographic and surgical presentation of a Class II furcation with a circumferential defect around the distal roots. Treatment of this case would require one to consider the likelihood of therapeutic success for both an intraosseous defect and that of a furcation. Can this be predictably treated?

Comparison of Treatment Options

This review will address the traditional treatment options to be considered when making an individual tooth prognosis. Comparing treatment options is a complex dilemma between relying on evidence-based dentistry and personal clinical experience-supported literature.

PERIODONTAL CONSIDERATIONS

Determining an accurate prognosis for each individual tooth and for the overall dentition is difficult. Forecasting individual tooth prognoses is usually based on clinical and radiographic parameters (e.g., radiographic bone loss, probing depths, clinical attachment levels, bleeding on probing, furcation involvement, and mobility). Classic studies by Hirshfeld and Wasserman and others have shown that even with highly compliant patients, it is almost impossible to predict the survival of a periodontally compromised tooth.[6-8] During the period these patients were maintained, tooth loss ranged from 6.2 percent to 9.8 percent with an annual average of 0.08 percent to 0.11 percent. Tooth loss for the treated but not maintained population was higher with an annual tooth loss rate of 0.22 percent.[9] These studies also generally indicated that it is more difficult to accurately forecast the prognosis of teeth with furcations and/or multirooted versus the single-rooted tooth (**FIGURES 1A-B**).

In a series of papers, McGuire and Nunn determined that clinical parameters were "ineffective in predicting any outcome other (than those teeth with) good" prognosis.[10-12] Forecasting accuracy for teeth assigned a good prognosis was accurate 81 percent of the time after eight years, but this dropped to 35 percent when applied to teeth with an initial prognosis of less than good. In a recent literature survey, long-term retention of teeth with questionable prognosis ranged from 38 percent to 97 percent.[5] A direct comparison of these studies is not possible due to differences in patient population, clinical evaluation parameters, maintenance methods, and the number/type of tooth monitored. Most importantly, there were no standard criteria to define a questionable prognosis.

Extensive research efforts have focused on clinical parameters as predictors of disease progression. Bleeding on probing is a poor predictor of periodontal disease progression and its absence on sequential visits has been shown to be a good predictor of no future attachment loss.[13] Several retrospective studies suggested furcation involvement was one of the main reasons for tooth loss.[6-8] In a review of therapeutic outcomes, retention rates of furcated teeth ranged from 43 percent to 98 percent suggesting that the actual retention rate is better than long-term prognostication.[5] Tooth mobility has also been proposed as a risk factor for attachment and tooth loss, but other reports suggest hypermobility is not always associated with advanced disease progression or worsening prognosis.[11,14-16] Some studies have suggested that deep probing depths predict future attachment loss.[17-19]

However, another study suggests that this relationship is not absolute.[19] Deep probing depth appears associated with a higher risk for further attachment loss, compared to shallow probing depth but further disease progression is not inevitable and treatment can reduce this possibility. It is the absence of deep probing depth, similar to bleeding on probing, which is a good forecaster of periodontal stability. These clinical parameters have not been reliable forecasters of disease activity.

In addition to the lack of reliable prognostic determinants for periodontal stability, the clinician is further hampered by patient management issues which may complicate the periodontal forecast. This first issue is patient compliance with home-care instructions and maintenance therapy appointments. Studies indicate that 20 percent to 30 percent of treated patients do not comply with the recommended maintenance therapy, and of those who do comply, approximately half are erratic in their care.[20-22] As expected, erratic compliers required more retreatment compared to patients who follow the home-care guidelines and regularly present for maintenance.[22] The second issue is systemic disease risk factors such as smoking, diabetes, and immunosuppression; these are not within the scope of this discussion, but it should be noted they contribute to

the difficulty of periodontal evaluation.

A clinical situation that is often under appreciated is the situation of a fractured tooth (**FIGURE 2**). In a desire to minimize financial expense and to save the tooth, cases of badly broken tooth are often treated endodontically and then referred for crown lengthening. In order to have this tooth restored, there has to be adequate root length so there is a patent seal for the root canal therapy. Then there needs to be an adequate length for post retention. Lastly, there has to be enough tooth length that will permit the 2 mm needed for the restorative ferrule effect and the 2 mm or more for biological width. In this example, evidence-based decision-making would have you consider the outcome success of the following parameters: success of crown lengthening procedures, root canal therapy, post size and space, adequate crown retention on natural tooth structure, and the availability of root structure and periodontium to withstand occlusal forces and then compare this to alternative plans, most obviously replacement with a dental implant.

When analyzed in conjunction with the clinical parameter studies, these issues result in a confounding combination of information. Like statistics where the odds that an event may occur under one situation are analyzed in a myriad of situations, the results are not additive, but synergistic. This is where the art of periodontal prognosis begins and why our opinions vary so widely. The decision to extract or preserve a tooth should be one based on knowledge of the literature, accurate clinical information (clinical parameter data and medical-social history), past clinical experiences and consideration of the patient's values.

FIGURE 2. A fractured anterior central incisor. For this tooth to be restored, 2 mm of ferrule space and 2 mm of biological width would be needed. How much root anchorage would be available for resistance to occlusal and functional load? Will the esthetics be acceptable? What will happen 10-plus years later when the tooth fracture and you have to consider implant placement at that point? If these considerations are obvious, why do we not consider similar situation for other teeth?

FIGURE 3. Radiograph of a fractured endodontically treated tooth at the base of the post on No. 10 and a perforation on tooth No. 11. How good is retreatment?

ENDODONTIC THERAPY

Classically, when a tooth has a pulpal involvement secondary to tooth fracture and carious lesion, endodontic therapy has been the treatment of choice. However, dental implants have become an alternative for such therapy. In a systematic review of the endodontic literature, the survival rate of root canal treatment followed by coronal restoration ranged 81.2 percent to 100 percent over the period of three to 25 years.[23] In this same review, the survival rates of single-tooth implants and restored endodontically treated teeth for five to 7.8 years were statistically similar.[23]

The authors concluded the decision to treat a compromised tooth endodontically or replace it with an implant should be based on factors other than treatment outcome. Endodontic factors to be considered include the presence/absence of periapical lesion, the type of endodontic treatment, and the postendodontic restorative situation. A case in point is the situation presented in **FIGURE 3** with a wide post on tooth No. 10 that has a fracture at the base and a perforation of the tooth. Endodontic treatment is not a singular treatment but one that requires other post-treatment procedures. When the outcome analysis or survival statistics are analyzed in addition to the endodontic procedure and when they are analyzed over a long length of time frame, the synergistic combination of failures may favor the decision for strategic extraction. Endodontic treatment of a new case is also different from those with other endodontic complications.

The presence of preoperative periapical lesions has been shown to decrease endodontic success rate by at least 10 percent.[24] A recent study reported that in the absence of such lesions, the healing rate was 94 percent compared to 79 percent.[25] Approximately 45 percent of the lesions slowly reduced in size. This has been interpreted by some as slow but progressing healing. Approximately 6 percent of the teeth still had a persistent lesion 10 years after treatment.[25]

Endodontic retreatment can significantly reduce the 97 percent success rate seen with initial endodontic therapy. Surgical retreatment of a poorly endodontic filled tooth can reduce the success rate by as much as 13 percent to 29 percent, with a reported mean healing rate of 78 percent.[26,27] These findings are consistent with a recent review which suggests the chance of success ranged from 37 percent to 85 percent, with an average of 70 percent.[28,29] In one study of endodontic retreatment, perforations were seen 12 percent of the cases.[30] The outcome and prognosis were so poor that these teeth were excluded from analysis.[30] These studies suggest that surgical

retreatment because root perforation and poor root filling quality is a strong predictor of poor endodontic outcome.

Though periapical lesions, root perforations, and poor endodontic fill are factors that complicate endodontic evaluation, the restorability of the endodontically treated tooth is of greater importance. Although a systematic review suggests that root canal treatment followed by coronal restoration has a similar success as implants.[23] The review has limited value because of the short mean time (7.8 years) used to evaluate tooth survival, the assumption that all endodontic treated teeth will be coronally restored, and monitoring occurred only after restorations were placed. The evaluation period may be too short to support the assumption is that all endodontic treated teeth can be successfully restored.

Clinical reality is that not all endodontically teeth are restored and other factors, such as post-placement fracture or perforation, types of posts inserted, form of supracoronal restorations and prosthetic issues, were not and may have resulted in overstating the success rate. In a survey of 12 studies with a six-year follow-up, 10 percent of teeth with posts had complications.[31] Other complications that concur with conventional single crowns include crown fracture (7 percent); loss of retention (2 percent); posts and cores loosening (5 percent); root fracture (3 percent); and caries (3 percent). Several studies reported that 24.2 percent to 85 percent of root canal-treated teeth were extracted because they were not properly restored.[32-34] Until there are more outcome studies which evaluate these individual factors, equating the success rate of endodontically treated teeth to that of implants should be accepted with the caveat that there are limitations to this comparison.

Prosthesis Therapy

There are limited longitudinal studies assessing the survival of fixed partial dentures to replace missing teeth. Additionally, the results are difficult to analyze because of different definitions of failure and follow-up periods. The one meta-analysis that assessed the overall effectiveness of FPD therapy reported that less than 15 percent of FPDs had been removed or needed replacement at 10 years; the figure rose to nearly one-third after 15 years.[35] In another study, the three most commonly reported FPD complications were caries (18 percent of abutments), need for endodontic treatment (11 percent of abutments), and loss of retention (7 percent of prosthesis).[31] These three most common complications are costly financially but also often require additional procedures which increases the chances for failure.

VETERAN PRACTITIONERS know that not every patient can accept the "best" treatment.

Implants

The efficacy and predictability of endosseous implants in treating partial and total edentulous cases have been well documented.[36-38] Regardless of the implant system used, functional success was achieved in more than 90 percent of the patients. In situations involving limited bone volume, socket or ridge preservation, guided bone regeneration (GBR), and distraction osteogenesis can be effective ridge enhancement techniques; nevertheless, the principle challenges in implant dentistry are to regenerate adequate bone volume and clinical esthetics.[39-40]

Though implant survival and function success rates are high, there are clinical complications. According to a review by Goodacre et al., the most common surgical complications were hemorrhage related, mostly of hematomas and ecchymosis (24 percent); neurosensory disturbance (7 percent); and mandibular fracture (0.3 percent).[41] However, most of the bleeding and neurosensory situations were transitory and had no effect on long-term implant success.[41] Other complications included implant loss in irradiated maxillae (25 percent), in Type IV bone (16 percent), and in diabetic patients (9 percent).[41] These latter complications and those observed with mandibular fracture are more accurately identified as issues relating to case selection and evaluated as implants placed in compromised sites or in high-risk patients.

Prosthetic complications included loosening of the overdenture retentive mechanism (33 percent), resin veneer fracture with fixed partial dentures (22 percent); implant loss with maxillary overdentures (21 percent); overdentures needing to be relined (19 percent); and overdenture clip/attachment fracture (16 percent).[41] It is interesting to note that most prosthetic complications are related to the use of implants with either overdentures or fixed removable prosthesis. Though these issues may be classified as complications, most of them are normal events associated with prosthetic maintenance and are generally correctable. From a functional perspective, esthetic complications occurred with a mean incidence of 10 percent and phonetic complications a mean incidence of 7 percent. From this survey, Goodacre et al. concluded that implants and implant prostheses had a trend toward a greater incidence of complications compared to single crowns, FPD, all-ceramic crowns, resin-bonded prosthesis,

and post and cores[41] (**FIGURE 4**). Although the incidence rate may be higher, most of the situations identified can be resolved with no long-term negative consequences. Lastly, the data collected included a wide cross section of implants used in compromising situations, such as removable denture design or in high-risk patients.

FIGURE 4. This tooth fractured. On examination, it had root caries, a previous history of endodontic treatment, minimal alveolar bone loss, and radiographically had a 12 mm root length. Which treatment will have a longer survival rate? Would you choose a conventional restorative approach with a new post and crown versus extraction and an implant-supported crown?

Discussion

Choosing the best treatment plan for our patients is an important facet of our practice. In general, it would appear that following the precepts of evidence-based dentistry and comparing therapeutic outcomes of implant versus traditional therapies often will result in a decision favoring implant replacement therapy. Sometimes, however, it is known that the best treatment plan is the one the patient will accept. Veteran practitioners know that not every patient can accept the "best" treatment. California law only tells us that we must inform the patient of the risks, benefits, and alternatives of treatment not that everyone has to have the best.

Strategic extraction has been, and will continue to be, a subject of debate with no clear algorithm for decision making. In the review of periodontal, endodontic, and prosthetic options, the conclusion is that this decision-making process is difficult. As outcome data is compiled, one can start to understand that any clinical situation may have a multitude of factors that need to be considered before a treatment plan is developed. An example is a carious pulpal exposure on a tooth with a furcation involvement. Instead of just considering the outcome of endodontic treatment, one needs to consider the periodontal prognosis of the furca, the success rate of the post-core installation, and the long-term crown survival.

With many situations, one may know the probability of successful outcome for any single aspect; but when there are so many confounding factors, the possibility of successful treatment decreases. In addition, the patient's concerns over losing a tooth, possible changes in esthetics, the length and cost of treatment, and others, must be considered in the decision-making process.

Because of the high success level of dental implants, there are concerns that teeth with a guarded prognosis will be prematurely extracted to be replaced with dental implants.[5] Though the authors share some of these concerns, the critical premise on which strategic extraction should be based is, do not take a stance of "watchful waiting." That is, do not postpone extraction until the situation deteriorates to the point where other options are eliminated or compromised. In most situations, implants are a good functional and esthetic option. A major key to implant success is adequate bone volume; ideally, native bone. Strategic extraction should be considered if other therapeutic options compromise the potential to obtain or preserve this bone volume. Situations when this guiding principle may not apply are elderly patients where there are other serviceable options, when satisfactorily esthetic results cannot be achieved, or when the patient objects to a perceived premature tooth loss.

Currently, one of the main limitations to successful implant placement is inadequate bone volume at the recipient site. One's ability to work with compromised sites has improved with the variety of techniques available for increasing bone volume through ridge preservation, augmentation, sinus grafting, and distraction osteogensis.[39,40] Incorporating recombinant biological modifiers such as human recombinant bone morphogenetic protein and platelet-derived growth factors can enhance bone formation.[42-46] Should these recombinant biologic modifiers become an integral part of implant site preparation, this may change how we define the critical time point to implement strategic extraction.

Conclusion

There is an ingrained tendency for dentists to try to save teeth. This review applying the precepts of evidence-based dentistry would suggest there are many occasions where strategic extraction is an appropriate alternative. This review will also indicate that these decisions are not always easy. Although periodontists are viewed by the dental profession as experts in forecasting tooth prognosis, we have no infallible method of making these decisions. As we increasingly accept evidence-based dentistry as a basis for practice decisions, we have discovered there are limited outcome studies that are the foundation for this approach to treatment. Further complicating the decision-making process is that many clinical situations require us to consider a multitude of confounding factors.

Nevertheless, we recognize there is a critical point where elective or strategic extraction is the best solution for dealing with compromised dentition. Because of the high success rate of dental implants, this critical point has shifted toward an earlier strategic extraction to preserve the bone volume necessary for implant place-

ment. Additionally, with the availability of recombinant biologic modifiers, this critical point may shift again. The critical point for each practitioner will reflect individual interpretation of the outcome studies discussed in this paper and personal experience. It is important to re-emphasize the patient's age, personal preferences, and finances must always be part of the decision-making tree.

In summary, due to the acceptance of dental implants, the emergence of biologic modifiers as potential enhancers of implant site preparation, and the growing reliance on evidence-based dentistry, our profession needs to change our view of prognosis and its clinical implications for treatment. ■■■■

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