The Decision Fork in the Road: When to Treat, When to Refer, and When It’s Time for Titanium

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Effective Date: 11/1/2013  Expiration Date: 11/1/2016

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Disclosure: Dr. Moody is a paid consultant for BioHorizons Dental Implants Systems and is a paid speaker for Imaging Sciences.

INTRODUCTION

It is the contention of the authors that the best implant is the natural tooth. When the natural tooth is not restorable, implants are a safe, predictable, functional, and aesthetic option for natural tooth replacement. Given the literature available and our clinical experience, we view endodontics and implants to be complementary and not competitive alternatives.\cite{1-7} This article will discuss optimizing endodontic treatment and discuss when tooth retention is and is not advisable or predictable. In essence, this work is intended to aid the clinician in deciding when to treat, when to refer, and when it's time for titanium.

For any tooth with pulpal disease or a failed root canal, 2 primary options exist: either endodontic treatment (and possibly periodontal and/or orthodontic extrusion) to facilitate tooth retention; or extraction and replacement with a dental implant, fixed bridge, or removable prosthesis. Which of these choices is appropriate is based on criterion grouped roughly into (1) purely clinical evidence, and (2) patient centered emotional, financial, and temporal considerations. Personal bias on the part of the clinician has no place in this decision-making. Empirical opinion (based solely on previous clinical experience) absent a strong literature basis is such one expression of bias. Suggesting treatment based on the financial interest of the doctor is another.

Tooth Retention

Teeth are candidates for retention when all unintended and intended consequences of endodontics and retaining the tooth are considered and explained to the patient. As part of informed consent, the procedure, alternatives to treatment, risks of treatment, and patient’s questions must be addressed. The crown-to-root-ratio must be favorable, given the intended postendodontic function of the tooth and adequate clinical crown exists to provide a minimum 1.5 mm ferule. If such a ferule is not possible, orthodontic extrusion or crown lengthening should be considered. Mobility should be minimal or absent, and if the tooth is determined not to be vertically fractured, then treatment will not make the tooth unduly susceptible to vertical root fracture. Care should be taken to assure that the tooth has the mechanical stability (quality and quantity of remaining tooth structure and periodontal support) to function in the manner intended after retention. The final restoration contemplated must be fabricated to have the aesthetic qualities needed or required.
by the patient. If the tooth has a failed root canal, a careful evaluation should be made to evaluate whether it can be retreated (revised, re-engineered) with a predictable success equivalent to implant therapy.

**Extraction and Risk Assessment**

Teeth are candidates for extraction when the patient does not want to retain the tooth for any reason, and endodontic therapy is not predictable, taking into account all the clinical, financial, and personal factors discussed above.

Clinical principles correlated with success include maintaining the original position of the canal and the original position and size of the apical foramen, preparing a tapering funnel with narrowing cross sectional diameters, in essence for the preparation to mimic the shape of a tornado, and preparing a taper that is proportional to the external root dimensions that does not predispose the tooth to subsequent vertical root fracture. In addition, the master apical taper should allow conefit with tug back and ideal obturation hydraulics during down-pack with warm vertical obturation techniques (and warm techniques of all types). This taper should also optimize the necessary volume and space for activation of endodontic irrigants.

To achieve the objectives above, the clinician should seek to: prepare straight-line access; remove the cervical dentinal triangle in orifice shaping; achieve and maintain apical patency throughout the entire treatment; disinfect the root canal system to the greatest degree possible through mechanical preparation of the canal space and achieve chemical disinfection (optimal irrigation) prior to obturation; obturate (seal) the canal space in 3 dimensions from orifice to apex; place a core buildup to seal the orifices and obturation; and fabricate a crown (where indicated), which by its design, materials, and contours make periodontal maintenance simple and predictable. Aside from marginal integrity, the occlusion of the postendodontic crown should be harmonious with the remaining dentition and musculature.

Prior to initiating endodontic treatment, the clinician should always consider the anatomy of the tooth, and consider the optimal final prepared taper for the root, the optimal master apical diameter, and the optimal treatment algorithm and instrument system for the given anatomy. The clinician should determine if the chosen instrumentation...
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system can comprehensively manage the anatomy, and whether it has the required flexibility, fracture resistance, ease of use, etc, to prepare the tapers and sizes needed. Also worthy of consideration is the question of whether the chosen instrumentation system can be instantly converted from a crown-down approach to a step-back approach by altering the instrument sequence used. And finally, each clinician should determine if he or she is the best person to manage the given clinical situation given the time, experience, resources of supplies, equipment, and manpower to provide the patient the greatest benefit with the least risk. In essence to ask, would referral be a better option?

Preoperative Examination
Retention versus extraction requires a comprehensive examination. Such an examination, at a minimum, aside from a review of the medical and dental history, requires a “SOAP” analysis. The patient's subjective (S) and objective (O) findings are recorded and evaluated, an assessment (A) made, and a plan (P) of action determined.

Evaluating and recording the same clinical findings reproducibly for every patient is invaluable to assure nothing has been missed in gathering the history. Specifically, with regard to the SOAP analysis, for every patient, the subjective symptoms should be recorded. Assembling this information often provides the diagnosis or alerts the clinician to what information needs gathering to make one. This information includes whether or not the patient is symptomatic. If the patient is symptomatic, the clinician must consider if the symptoms fit a common pattern of an irreversible pulpitis, symptomatic nonvital tooth, or a symptomatic failed root canal

Figure 4a. Tooth No. 20 was referred in the condition shown. The prognosis was poor given the bone loss, crown-to-root-ratio, calcification, root anatomy, over-extended previous access without canal negotiation and long-term risk of vertical root fracture. The tooth was referred to me for extraction and implant placement.

Informed consent about potential tooth loss has to start with a discussion of bone loss. With the amount of bone loss in the first year after tooth extraction being 10 times greater than the following years, ridge preservation or immediate dental implant placement should be considered.

When indicated, an immediate dental implant is often the best treatment. Successful immediate dental implant criteria success rates can be very high with patient acceptance and satisfaction and create raving fans of your practice. My criteria for immediate implant placement are:

- Medical history review with minimal risk factors (smoking, diabetes, bisphosphonate use, etc)
- Prosthetic outcome in mind favors immediate placement
- Temporary prosthesis treatment plan favors immediate implant placement
- Adequate bone verified by cone beam technology
- Dental implant selection for favorable outcome

I am a firm believer in “Do it once and do it right”; therefore, if an immediate dental implant is not indicated as a high success procedure, then the tooth will be extracted and the site grafted for future implant placement.

Using cone beam computed tomography (i-Cat Precise [Imaging Sciences]) and treatment planning software (TX Studio [Anatomage]), I was able to survey the available bone and make my implant selection based upon those parameters (Figure 4b).

Figure 4c shows the selected implant (Tapered dental implant with Laser-Lok technology [BioHorizons]) along with the virtual abutment and crown for planning of the final restoration.

The tooth was extracted and the dental implant was placed immediately. Figure 4d shows the final abutment in place 4 months postoperatively. This was a great service for the patient, as she had only one surgical appointment and was able to be fully restored in less than 4 months. As you can see, implants have their place and are a true complement to endodontics when you have the patient's best interest in mind.

JM (Figures 4a to 4d)
therapy (RCT) and further assess how long the symptoms have been present and whether there is tenderness to drinking hot and cold beverages, and if so, if the pain lingers. Also, important to the examination is the presence of nocturnal and spontaneous pain, when the last restorative treatment was provided in the area, what pain medications the patient is taking to relieve the pain, and if the patient suffers from temporomandibular disease (TMD) (acutely, or a long-term history of TMD), and/or has other parafunctional habits.

Aside from recording percussion, palpation, mobility, and probing, while not an exhaustive list, objective SOAP findings should include evaluating the medical and dental history, age, and alveolar bone including quality, quantity, and pathology. Radiographic assessment with cone beam computed tomography (CBCT) should be employed where indicated and 2-dimensional (2-D) periapical images taken from at least 2 angles (ideally 3) (Figures 1a and 1b). Also noted should be potential anatomic challenges (mental and inferior alveolar nerve proximity to the root apices, palatal roots in the sinus, size of the external oblique ridge, etc), root length, curvature, calcification, number of roots, root resorption (internal, external, combined internal and external), calcification of the pulp chamber, gingival soft tissue, and arch position. Patient dependent, second and third molars especially can provide significant access limitations.

Objective SOAP findings should also note the presence of a crown or

Figure 5. Excessive taper, canal transportation, and a lack of canal negotiation are evident in the treatment of tooth No. 19. Given the initial root length and width, the prepared taper in the mesial root is excessive and the canals transported. The best possible chance for negotiation of the mesial and distal roots was to have spent the needed time with small stainless steel hand files (Mani K files and Mani D Finders) negotiating these roots to the apex and possibly using a step-back approach.

Figure 6a. Separated file in the mesial root of No. 30.

Figure 6b. File fragment bypassed.

Figure 6c. Canal obstruction removed.

Figure 6d. Mani SEC O K hand files.

Figure 6e. Mani K files.

Figure 6f. Mani D Finders (used in negotiation of calcified and curved canals).
bridge. If access is being made through either a crown or bridge, treatment is more complex. When in doubt, remove crowns before endodontic access. Crowns often hide coronal and cervical fractures, caries, temporary restorative materials, and internal resorption, among other unexpected findings not revealed by radiographs.

Restorability including active caries and remaining tooth structure, crown-to-root-ratio, furcal status, previous periodontal surgery, history of smoking, quality of oral hygiene and caries index, bruxism, TMD, presence and severity of coronal fractures, perio-endo combined lesions, and intended tooth function after RCT should also be noted. While retention may be feasible, it may not be advisable. For example, if an upper second bicuspid with minimal tooth structure is intended to act as a bridge abutment with a post-retained crown, the risk of vertical root fracture is high.

The objective examination also includes, among other findings, possible pre-existing vertical root fracture, tipping, rotation, high furcation, degree of root fluting, open apices and immature roots of all types, alveolar ridge positioning—buccal or lingual, severe tooth crowding, atypical anatomy (second canals on lower canines, upper first bicuspid with 3 roots, C-shaped lower second molars, dens in dentae, fused roots, etc), trauma cases of all types (luxation, subluxation, etc), dental anxiety (including but not limited to a limited opening, gag reflex, inability to tolerate the rubber dam and/or not be able to be reclined fully in the chair), pre-existing iatrogenic events (perforation, rotary Ni-Ti file separation, canal transportation, canal blockage among others), and failed previous endodontic treatment (see below) (Figures 2 to 4d).

Among others, the objective findings above allow the clinician to determine treatment risks, indication for referral, and provide strong clues to the predictability of tooth retention.

In addition to the above, the clinician should realize he or she may not know the entire picture despite having CBCT, 2-D x-rays, and a clinical examination. Clinical entities can evade detection in x-rays. The clinician can be surprised (either favorably or unfavorably) with the true condition of the tooth once the crown is removed and retreatment commences. For example, what may appear radiographically to be gutta-percha can turn out to be paste. Paste removal can be highly problematic, depending on its composition. Possible clinical scenarios are infinite, but the advisability and predictability for endodontic retreatment require caution and clinical judgment (Figures 5 to 6f).

**Endodontic Principles Correlated With Treatment Success**

The following endodontic clinical principles are time honored and correlated with success: referral is the best clinical strategy when the clinician is not entirely comfortable with the case given one’s time, skills, equipment, and/or staff.

Informed consent is essential prior to initiating treatment. Adequate informed consent breeds confidence. Patients tend to be more understanding when a possible clinical misadventure has been discussed in advance than one which occurs as an unpleasant surprise in a procedure that is perceived by the patient as hurried or poorly thought out.

Other success strategies include anesthesia that is
tested and profound before access, anxiolytics (nitrous, oral sedation, IV sedation) employed as indicated, utilization of the rubber dam, a bite block for access limitations, optimal magnification and visualization (ideally through a surgical operating microscope, or at a minimum, loupes), and use of posts only in clinical cases where needed to retain the buildup when tooth structure is lacking (and a minimum 1.5-mm natural tooth ferule can be achieved). Canal irrigation should also be copious and activated (sonic, ultrasonic, negative pressure, etc).

Proper team training prior to treating live patients cannot be overstated in its value. Every team member, whether directly or indirectly involved in treatment, should understand the fundamentals of endodontic treatment. The endodontic patient is often already in an altered state of mind by hearing the phrase, “You need a root canal.” Having a properly trained team that delivers a unified message from the first phone call through the recall visit can put the patient at ease as much as possible by portraying knowledge, confidence, and professionalism.

The correct instruments and supplies in the quantities needed must be present to facilitate efficient treatment. For example, having an adequate supply of correctly sized Mani D finders (or similar stainless steel hand files designed specifically for calcified canals) is very helpful in difficult anatomy.

For both the clinician and the team, understanding why and how each instrument is used is critical. For example, using a safe-ended hand file (Mani SEC O K hand files) to reciprocate (with a reciprocating handpiece attachment) is critical to avoiding canal transportation when using reciprocating hand files larger than No. 10. Reciprocating a more aggressive cutting hand file can ledge, block, and perforate canals.

Anatomy dictates technique. “Cookbook” treatment algorithms are not helpful when the tooth has not read the cookbook. Ideally, the clinician should be able to seamlessly change technique approaches midtreatment when a particular anatomy dictates a different methodology. For example, if a crown-down approach is not efficiently shaping given the anatomy present, the clinician should be able to switch to a step back approach or perform a hybrid technique that is customized to the given root.

The clinician should have several obturation methods at one’s disposal to ideally manage a variety of clinical anatomies. For example, in a root with a blocked apex, it may be more efficient to obturate the canal with a device that extrudes gutta-percha rather than using a master cone. Such a skill requires practice, a complete understanding of gutta-percha’s thermal characteristics, mastery of the device, and lighting and magnification (Figures 7a to 8b).
IN SUMMARY
This article has discussed decision making for tooth retention versus extraction. Emphasis has been placed on risk assessment, informed consent, and use of principle centered endodontic treatment. In essence, this article was written to aid the clinician in deciding when to treat, when to refer, and when it’s time for titanium. We welcome your feedback.

REFERENCES
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1. For any tooth with pulpal disease or a failed root canal, 2 primary options exist: either endodontic treatment (and possibly periodontal and/or orthodontic extrusion) to facilitate tooth retention or extraction and replacement with a dental implant, fixed bridge or removable prosthesis.
   a. True   b. False

2. The crown-to-root ratio must be favorable given the intended post endodontic function of the tooth and adequate clinical crown exists to provide a minimum 2.5 mm ferrule.
   a. True   b. False

3. Aside from marginal integrity, the occlusion of the post endodontic crown should be harmonious with the remaining dentition and musculature.
   a. True   b. False

4. Radiographic assessment with cone beam technology should be employed where indicated and 2-dimensional periapical images taken from one angle.
   a. True   b. False

5. The clinician can be surprised (either favorably or unfavorably) with the true condition of the tooth once the crown is removed and retreatment commences.
   a. True   b. False
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