

# Restorative Considerations in Deciding Whether to Restore or Remove Endodontically Treated Teeth

## Abstract:

The interdisciplinary team is often confronted with the decision of whether to retain or remove questionable teeth that have already been treated endodontically. The purpose of this article is to review the restorative criteria that must be met in order for these teeth to be predictable over the long term. In many instances, the decision of whether to restore or remove a tooth is quite clear. Untreatable periodontal conditions, untreatable endodontic conditions, unmanageable root resorption, or root fractures make the decision to remove a tooth an easy one. For the purpose of this article the author is going to assume that the teeth in question are treatable endodontically as well as periodontally and focus specifically on the issues of restorative predictability.



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## Learning Objectives

*After reading this article, the reader should be able to:*

- discuss the criteria that must be met during the restorative decision-making process to ensure long-term predictability of teeth that have already been treated endodontically.
- identify the three major aspects to consider when deciding whether to restore or remove a tooth that is biologically healthy.
- describe the major causes in the failure of restored teeth that had been previously treated endodontically.

There are essentially three major aspects to discuss when considering whether to restore or remove a questionable tooth that is biologically healthy. The first is structural—is it possible to restore the tooth in such a manner that a good long-term prognosis exists? The second is esthetic—is it possible to create a pleasing final appearance and maintain the tooth? And the final area is value—what will the cost be both financially and in time and energy to maintain the tooth as opposed to removing it?

## Structural Issues

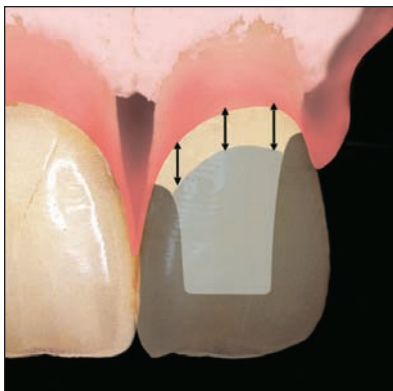
The structural issues of whether to retain or remove a tooth relate to the amount of remaining tooth structure. If the tooth has had endodontic therapy, has the majority of its coronal form remaining, and is endodontically and periodontally healthy, there is little question in most cases about whether to remove or restore the tooth.

Making the decision to restore or remove teeth that are biologically healthy but missing the majority of their coronal form is not always clear. In these teeth, which often are fractured, the challenge is getting the necessary tooth structure to make a predictable restoration. It is helpful at this point to discuss how much tooth structure is necessary.

Classically, prior to the era of adhesive bonding, the geometry of the tooth preparation was solely responsible for retention and resistance form. In that

era, the typical goal in describing an adequate tooth preparation was 3 mm of vertical height with 6° of taper.<sup>1</sup> The ability to bond a restoration has altered those requirements to some degree, although it is difficult to identify specifically how little tooth structure is an acceptable amount for both retention and resistance form when bonding is used. There is, however, a significant amount of clinical research that identifies the method of failure of endodontically treated teeth when inadequate tooth structure was available and the tooth had been restored with a post and core.<sup>2</sup> The most common failure is a loss of retention of the post, the core, and the crown, with the result that the patient arrives at the office with the restoration in their hand. The second most common method of failure is a fracture of the post with the crown and core now in the patient's hand, but the post still cemented in the tooth. And finally, the third most common method of failure is the root of the tooth splitting vertically.

All of these methods of failure have been linked to a lack of tooth structure or, more specifically, what is known as a lack of ferrule.<sup>3</sup> *Ferrule* is defined as the amount of tooth structure between the margin of the restoration and the margin of the build-up (Figure 1). To understand how ferrule plays a role in failure, it is helpful to consider how forces are applied during function.



**Figure 1**—The concept of ferrule, the amount of tooth between the margin of the build-up and the margin of the restoration.

Using a maxillary anterior tooth as an example, loading during excursive movements or during the incising of food creates a compressive force on the facial margin of the restoration and a tensile force attempting to open up the lingual margin of the restoration (Figure 2). Normally, the stiffness of the dentin, combined with the quality of the restoration, prevents any kind of failure under load. Compare the loading of a tooth that is fractured level with the gingival tissue to the retention and resistance of the entire restoration supported by a post and core, and one can understand how, under loading, the management of any forces depends on the quality of the post and core because there is no natural tooth structure to which the crown is cemented (Figure 3). The more flexible the post, the more likely the lingual margin is to open up because of the tension that occurs with the occlusal forces.

Once the lingual margin has opened, it is now possible for leakage to enter the gap between the crown and the tooth and start working its way toward the post and apically in the canal. When the leakage moves far enough in an apical direction that there is an inadequate amount of post still cemented to retain the core, then the post, core, and the crown all fall out. This entire event is often preceded for months and sometimes years by the patient presenting with a complaint of a bad taste or offending odor around the questionable tooth. And yet, at each appointment the margin of the restoration seemed intact because the crown was still cemented to the core and the post was still cemented in the canal. The more rigid the post, the more

likely the post is to potentially fatigue and fracture, resulting in the loss of the crown and core or, worse, a vertical fracture of the root of the tooth.

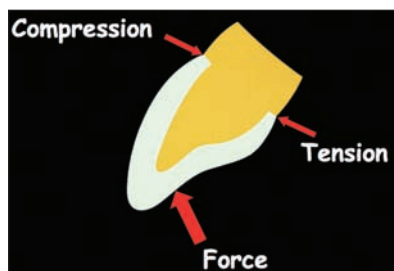
One of the major goals in making the decision to restore or remove an endodontically treated tooth is to determine if adequate tooth structure exists to prevent the types of failures described previously, and if not, determining if could it be created. Knowing how much tooth structure is necessary, and where it necessary, is a key part of this decision-making process.

## Literature Review

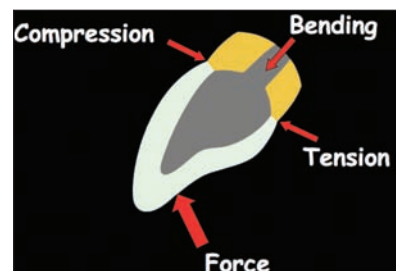
To answer these questions, the author is going to reference a series of research projects that have evaluated the influence of the amount of tooth structure, type of build-up, type of post, and the method of luting to the fatigue resistance of the final result. And while many research articles have been published on this topic, the author is going to use a specific series of articles done by students from the University of Washington postgraduate prosthodontics program. The

author was not directly involved with any of this research, but because he graduated from the same program 25 years ago, he is very aware of how each article evaluates a specific variable in the fatigue resistance of the restoration of endodontically treated teeth. At the heart of this series of articles is the concept that fatigue resistance is the critical element in the long-term predictability of endodontically treated teeth. Success requires a tooth be able to accept repeated forces at a lower level to succeed long term rather than be resistant to one maximal traumatic event. This varies significantly from the common methodology of using an Instron machine and increasing the load until a traumatic failure occurs as a way of in vitro testing different restorative variables.

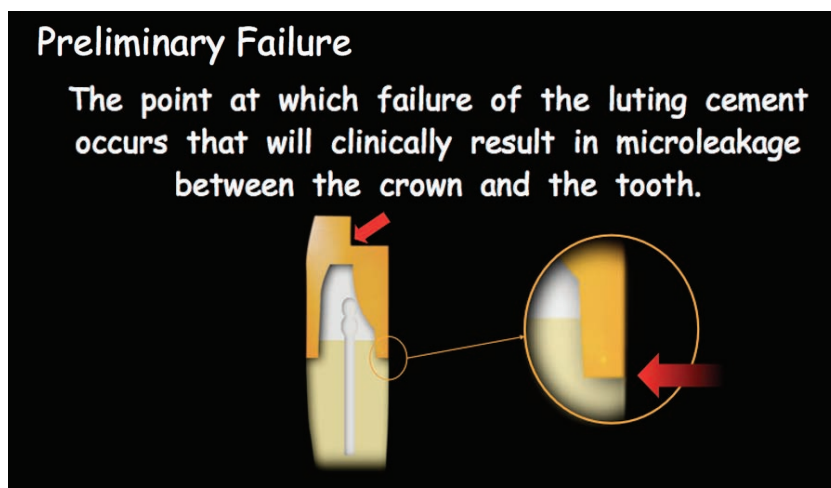
In the first study, Libman compared the amount of remaining ferrule and its influence on when preliminary failure occurred.<sup>4</sup> *Preliminary failure* is defined as the moment the restoration margin opens up, loses its integrity and begins the microleakage process (Figure 4). But because the restoration is still cemented



**Figure 2**—An illustration of the distribution of compressive and tensile forces on a normal restoration.



**Figure 3**—An illustration showing that when the tooth is even with the gingival level, all of the resistance to force is borne by the post and core.



**Figure 4**—The concept of preliminary failure, when the margin of the restoration is no longer cemented to the root of the tooth.

to the build-up and the post is still cemented in the canal, the restoration appears clinically sound. Libman's focus was to use standardized-length, cast-gold post cores cemented with zinc phosphate into extracted central incisors. The length and dimensions of the tooth preparations were kept as identical as possible. The only variable was the difference in the ferrule length for each of the samples, varying from a control with no post core, up to a 2-mm ferrule, in 0.5-mm increments. A cast-gold crown was cemented using zinc phosphate on top of the preparation and build-up. The complete restoration and extracted root was embedded in an acrylic block and prepared for fatigue testing. A strain gauge was cemented over the lingual margin of the restoration to act as a chart recorder. This recorder was able to read any change occurring at the lingual margin under tension from repeated loading or fatigue. The results showed that it took only 213 cycles to produce preliminary failure when a 0.5-mm ferrule was present; 1,140 cycles when a 1-mm ferrule was present; 71,651 cycles when a 1.5-mm ferrule was present; 70,045 cycles when a 2-mm ferrule was present; and 91,208 cycles for the control natural tooth.

The data from this study clearly showed that at least a 1.5-mm ferrule for predictable fatigue resistance is required. The challenge of Libman's original model is that the materials and techniques used—namely cast-gold post cores and zinc phosphate cement—are not used as commonly today. It was therefore necessary to create a series of research studies using the same methodology as Libman but altering specific variables to see their impact. In evaluating the variables that must be controlled when restoring endodontically treated teeth, the cement used to retain the post, the cement used to retain the restoration, the type of post used, and the type of build-up material used must all be considered.

Junge modeled his research after Libman's using extracted central incisors, cast-gold post cores cemented with zinc phosphate cement, and a 1.5-mm circumferential ferrule, but he altered the cement used to place the cast-gold crown.<sup>5</sup> After cementation of the cast-gold post cores and the creation of the

1.5-mm ferrule, the teeth were separated into three groups: in Group 1 the cast-gold crowns were cemented with zinc-phosphate cement; in Group 2 the crowns were cemented with a resin-modified, glass-ionomer cement; and in Group 3 the crowns were placed with an adhesive resin cement. Again, each tooth was mounted in an acrylic block with a strain gauge cemented to the lingual margin and placed into the device for fatigue testing. The load used in Junge's study was different than that used in Libman's, therefore, a direct correlation of the numerical values required to achieve failure cannot be made between the two studies. However, Junge used zinc phosphate cement as one of his variables, so the impact of the different cements on the number of cycles required to reach preliminary failure can be easily seen. In Group 1, failure occurred at 5,646 cycles. In Group 2, failure occurred at 6,795 cycles. In Group 3, failure was not recorded because the machine was shut off at 100,000 cycles and none of the teeth had yet failed.

This study clearly shows the importance of using adhesive resins in cementing the final restoration over any post and core build-up. And yet it leaves several unanswered questions. Would the results be the same if the ferrule was less than 1.5 mm? Would the results be the same if a different post-and-core system had been used? How would the results vary if the ferrule was not the same height circumferentially around the tooth? To answer these questions it will be necessary to complete another series of studies looking at different variables.

Thu did exactly that, also using three groups as Junge, except that he used resin cement to place all of the posts and cores, followed by glass-ionomer cement to place the crowns over the posts and cores.<sup>6</sup> Like the others, a circumferential 1.5-mm ferrule was used for each tooth. Comparing the results of Thu's research to Goto's is quite astounding given that the only changed variable was the cement used to place the posts. Group 1 (cast-gold post core) required 163,326 cycles to reach failure; Group 2 (the stainless steel para-post with a bonded core) required 244,315 cycles to reach failure; and Group 3 (fiber post with composite core) required

40,511 cycles to reach failure, which is very similar to the number from Goto's study using identical methods for placing the posts, core, and crown.

In analyzing the results from these three studies, several things become obvious. First, the type of cement used to retain the crown over the post and core has an enormous impact on fatigue resistance, with adhesive resin being dramatically better than zinc phosphate or resin-modified glass ionomer. The same dramatic change can also be seen when comparing the different methods of luting the post in the canal, with adhesive resin being the clear choice. Two questions, however, remain unanswered. First, is it necessary to have a ferrule circumferentially around the tooth? And second, is it necessary to have a 1.5-mm ferrule if adhesive resin is used to place the post core and the crown?

Wong was interested in whether a circumferential ferrule was necessary.<sup>7</sup> Using the fatigue apparatus described previously with extracted natural teeth, bonded fiber posts, composite cores, and cementing the crowns with a resin-modified glass ionomer, his study was separated into two major groups. Group 1 had a 2-mm circumferential ferrule. Group 2 had the margin of the preparations scalloped to provide 2 mm of ferrule on the buccal and lingual surfaces, but none interproximally. The findings were very conclusive in that the critical location for the ferrule is on the buccal and lingual surfaces, and whether any ferrule was present interproximally did not affect the outcome. This is quite easy to understand when the distribution of force to the restoration during loading is evaluated, with the facial surface being compressed while the lingual surface experiences tension but the mid-interproximal is essentially a zone of no stress (Figure 5). The final question remaining is whether it is, in fact, necessary to have a 1.5-mm or 2-mm ferrule if adhesive resin is being used to place the post core and the crown.

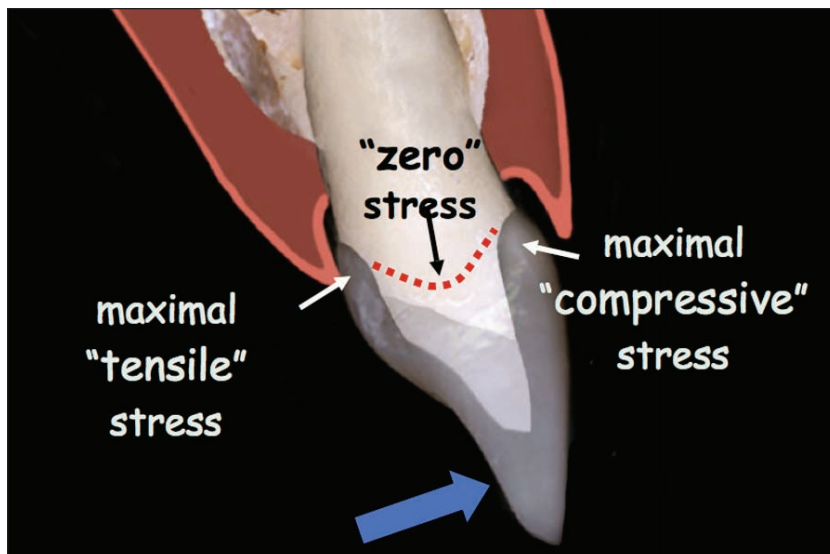
Ma developed a study<sup>8</sup> where the variable to be altered was the actual height of the ferrule, again using a similar methodology to the previous studies. Each group consisted of a fiber post and composite core, both bonded to place, and an

all-ceramic crown also bonded to place. The variables were: Group 1, no ferrule; Group 2, a 0.5-mm circumferential ferrule; and Group 3, a 1-mm circumferential ferrule. An analysis of the results shows how critical the adhesive resin cement is to success, but also points to the necessity of having some ferrule present. Group 1 failed in only 213 cycles; Group 2 failed at 155,137 cycles; and Group 3 failed at 262,872 cycles.

Clearly the fatigue resistance and long-term predictability of an endodontically treated tooth are affected by the amount of ferrule, the cement used to retain the crown, and the cement used to place the post and core. At this point it is difficult to identify how much importance the post/core system used has in the fatigue-resistance process. From Thu's work, when resin-modified, glass-ionomer cement was used to retain the crown, the stainless-steel post bonded in place with a composite core required the most cycles to failure, followed by a bonded cast post core and the weakest of the three, the bonded fiber core. However, we do not have research that compares the three post/core systems to each other when the crown also was bonded, but it would appear that the choice of post may be the least important decision one has to make in how to restore an endodontically treated tooth.

In using the previous research as part of the decision-making process for whether an endodontically treated tooth should be restored or removed, it is obvious that the ability to get a 1-mm ferrule on both the buccal and lingual surfaces is critical to long-term success. And, any restorations done where no ferrule is present regardless of the adhesive or the post used is doomed to early failure. In addition to the height of the ferrule, it is also important to note that the thickness of the remaining walls of the tooth will have an impact on the success of the ferrule. That is, a 1-mm-tall ferrule that has only a few tenths of a millimeter of wall thickness is probably inadequate.

Unfortunately, the author is unaware of any research that has evaluated the thickness of the remaining walls on long-term success. Another important question in determining whether to



**Figure 5**—An illustration showing a lack of compressive or tensile force at the mid-interproximal, eliminating the need for an interproximal ferrule.



**Figure 6**—Facial view of a fractured endodontically treated tooth with minimal facial ferrule.



**Figure 7**—The same tooth in Figure 6, showing minimal lingual ferrule.



**Figure 8**—After minor palatal crown lengthening and the placement of a tooth-colored post and core, it is possible to gain 1.5 mm to 2 mm of palatal ferrule.

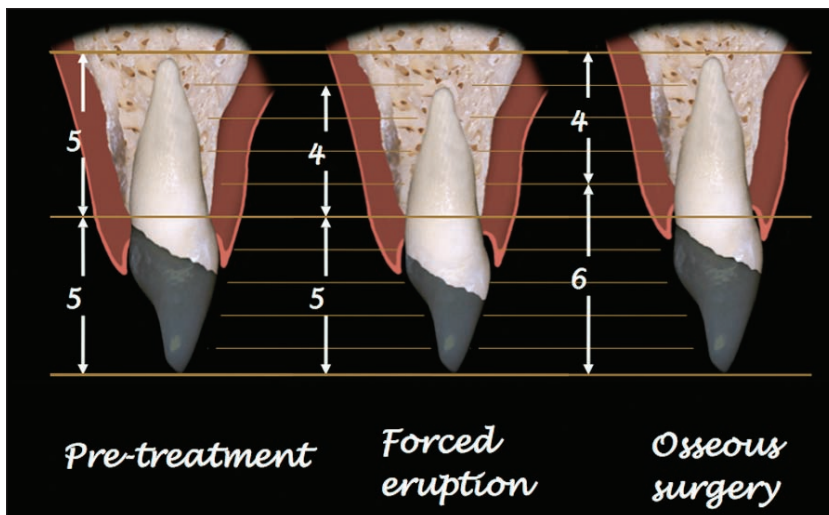


**Figure 9**—The completed restoration.

restore or remove an endodontically treated tooth is whether or not a ferrule can be created on the tooth in question without long-term negative implications for the patient.

In general, two methods exist to create a ferrule when one is absent. The first is surgical in nature, apically positioning the gingival tissues either through gingivectomy or osseous surgery to expose more of the tooth, allowing a ferrule to be created when the tooth is prepared

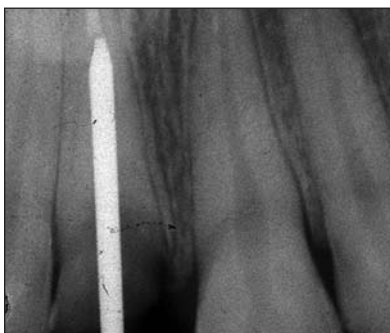
(Figure 6 through Figure 9).<sup>9,10</sup> The second is to use orthodontic extrusion to erupt the tooth to a more coronal level, followed by apically positioning the tissue to expose the required tooth structure.<sup>11-14</sup> In some cases this orthodontic extrusion can be done quite rapidly, attempting to pull the tooth out of the attachment and avoid the secondary surgery. Whether surgery or orthodontic extrusion is attempted to obtain a ferrule the net effect will always



**Figure 10**—An illustration comparing the different methods of obtaining a ferrule on a fractured tooth, eruption vs crown lengthening. Note the differences in crown-to-root ratio between the different techniques.



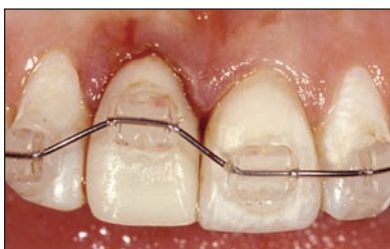
**Figure 11**—A patient with a severely fractured maxillary right central incisor. Endodontic therapy, a post and core, and a temporary crown have been placed.



**Figure 12**—A radiograph showing that the extent of the fracture on the right central incisor, from the most apical portion of the fracture to the apex of the tooth, is 12 mm and the decision was made to erupt the tooth to obtain a ferrule.



**Figure 13**—The extent of the lingual fracture going 0.5 mm below the palatal crest of bone.



**Figure 14**—Because it will be necessary to expose 4 mm of tooth above the crest of bone, the orthodontics has been set up to erupt the tooth 4.5 mm; in addition, a fiberotomy was performed to the crest of bone.



**Figure 15**—The tooth after the orthodontic extrusion. Note the gingival levels have remained the same but the margin of the restoration is now exposed.



**Figure 16**—Following three months of healing note the gingival health and a 1.5 to 2 mm ferrule apical to the margin of the buildup.

be that there will be less root in the bone after treatment than there was before treatment; surgery will often remove bone and increase the crown-to-root ratio, and eruption pulls the root out of the bone, again reducing the crown-to-root ratio, although not as severely as surgery alone (Figure 10). As a general rule, whether using surgery or forced eruption and surgery, it will be necessary to have at least 4 mm of tooth exposed above the bone on both the buccal and lingual surfaces. This allows for a 1.5-mm ferrule to be prepared while maintaining the margin 2.5 mm from the underlying bone. In addition to determining how much tooth structure needs to extend coronally to the bone, one must consider the amount of root that will remain in the bone when determining whether the tooth should be retained or removed.

Classically, clinicians have spoken of wanting to maintain a 1:1 crown-to-root ratio when deciding to retain a tooth or to remove it.<sup>15</sup> The challenge, of course, is that all clinicians have seen patients with significantly less than a 1:1 ratio and yet completed a very successful restoration. It is necessary for clinicians to decide how much root is believed to be necessary to choose restoration vs removal. For a maxillary anterior tooth, if the author can retain 8 mm to 9 mm of root in the bone he will generally consider retaining the tooth. Because 4 mm of tooth structure is needed coronal to the bone, this means that the tooth must be 12 mm to 13 mm long to have 8 mm to 9 mm of root in the bone and 4 mm coronal to the bone. If these dimensions cannot be met it is difficult to predict long-term success and removal should be considered (Figure 11 through Figure 17).



**Figure 17**—The completed smile view of the patient seen in Figures 11 through 16. Note the maintenance of gingival levels and interproximal papilla because eruption was used to obtain the ferrule rather than surgery.

The one exception to these rules is the young patient who has not completed growth. In these patients, the maintenance of a root—no matter how weak or how inadequate the ferrule—is a better choice than removing the tooth at a young age and dealing with the consequences later. It is far better to attempt to maintain the tooth, knowing that it will eventually fail, but getting the patient through the critical period of growth and then determining how to ultimately replace the tooth.

Another structural factor that must be taken into account when determining whether to consider restoring a tooth or removing it is to consider whether the tooth will have excessive forces placed on it. Does the patient have a history of severe parafunction or bruxism? If so, it is extremely important that the tooth meet the ideal requirements of ferrule height and wall thickness if it is to succeed. If that is not possible, it is probably in the best interest of the patient to remove the tooth and consider some form of replacement. The same is also true if the tooth is to be a terminal abutment for a complex fixed prosthesis. The opposite of these circumstances also applies. If the patient has no history of tooth wear and the tooth is to be a single-unit restoration, particularly in the anterior, it may be possible to have less than the ideal ferrule height or wall thickness and still be successful, albeit less predictable, than if more tooth structure was present.

## Esthetic Issues

In addition to the structural requirements described previously concerning whether a tooth should be restored or removed, there are other considerations that have to be taken into account, specifically the impact of retaining or removing the tooth on esthetics. There are situations where it would be possible to create an acceptable ferrule on a maxillary anterior tooth and have adequate root length in bone, but the resulting gingival esthetics would be completely unacceptable because of the surgical procedure necessary to expose adequate tooth structure. In these cases, removal of the tooth and replacing it with either an implant or a fixed prosthesis would better serve the patient

over the long term than removing bone and gingiva and leaving the patient in a less desirable situation for future tooth replacement (as well as dealing with a less pleasing esthetic result after the current treatment). Not doing heroic treatment to save an isolated single anterior tooth also makes sense because of the predictability of tooth replacement for single missing anterior teeth. A large part of this predictability is that the presence of adjacent teeth ensures good interproximal bone height with acceptable interproximal papilla heights, unless prior bone loss has already occurred. As a general rule, if the tooth to be removed has no periodontal disease, it is possible to replace it very predictably using a single-tooth implant and get a very pleasing esthetic result, largely due to retaining the adjacent natural teeth (Figure 18 through Figure 21).

There are times, however, when there may be multiple questionable teeth and the clinician must decide whether to remove all of them or retain some of them. If none of them can be managed structurally, the decision would typically be to remove them all and replace them prosthetically. In certain instances, however, the ability to retain one or two maxillary anterior teeth can greatly enhance the final esthetic outcome of the restoration because of their ability to retain interproximal bone.

For example, retaining one maxillary central incisor and the opposite maxillary lateral incisor has the ability to maintain the papilla heights across all of the maxillary anterior teeth if implants are used to replace the missing teeth. The retained maxillary central will maintain the papilla between the opposite central and the lateral incisor implant on the side of the retained central. The retained lateral incisor will maintain the papilla between it and the maxillary central that is replaced by the implant on its side, and also will maintain the papilla between it and the canine that is replaced by an implant on the same side. Treatment planning to maintain some isolated maxillary anterior teeth is especially helpful in patients who are very esthetically conscious and have a high lip line. There are many cases where esthetics need to



**Figure 18**—A patient with an extremely high lip line and a fractured right central incisor.



**Figure 19**—The adjacent teeth are periodontally healthy and it would be virtually impossible to save the root of the right central and have the restoration be predictable.



**Figure 20**—A photograph following the removal of the root placement of an implant and five months of healing. Note the excellent papilla due to the maintenance of the adjacent teeth.



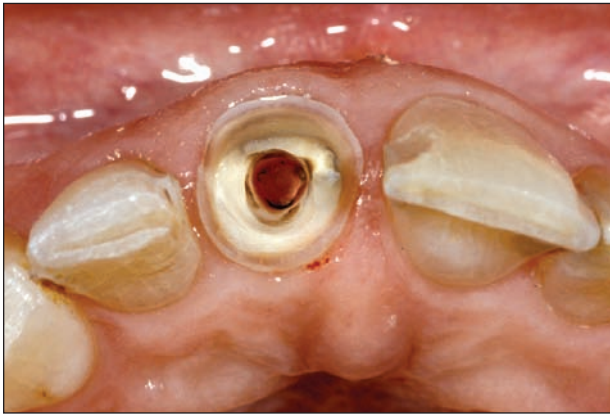
**Figure 21**—A four year recall photograph of the patient seen in Figures 18 through 20.



**Figure 22**—A patient presenting for esthetic enhancement with an endodontically treated maxillary right central incisor with a large access cavity.



**Figure 23**—As the tooth is prepared it is also obvious the root is moderately discolored.



**Figure 24**—An incisal view shows how thin the walls of the remaining tooth structure are; a normal 1.2 mm reduction on the facial would remove the entire facial wall.



**Figure 25**—The solution was to utilize thin bonded ceramic crowns with a zirconium oxide and pressed ceramic post and core minimizing the amount of facial reduction that had to be performed.



**Figure 26**—Internal bleaching was performed on the right central incisor minimizing the need for a thick restoration to mask the discolored root.



**Figure 27**—A six year recall photograph of the final restorations in place.

be considered in addition to the structural condition of the tooth when deciding if the patient is better served by retaining and restoring the tooth or removing and replacing it (Figure 22 through Figure 29).

### The Value Aspect

The final area that must be evaluated with regard to restoration vs removal

is value, specifically, what are the costs vs the benefits to the patient when comparing the retention of the tooth vs the removal and replacement of the tooth. And value is something that only the patient can determine. It is not up to the clinician to determine whether maintaining a tooth, even if it only lasts 2 more years, is worth it, but rather it is up to the patient to be informed of

the potential costs, the potential risks, and what it will mean if there is early failure of the retained tooth. Before the evolution of implants, it was rare to not consider going through heroic means to retain a tooth. In fact, it was common to consider endodontic therapy, a cast post core, crown-lengthening surgery, and the final restorations as a necessary part of treatment planning to



**Figure 28 and Figure 29**—Comparative frontal smile photographs pre- and post-treatment.

provide patients with a fixed restoration. Today, however, with the predictability of implants and the high cost of endodontic therapy, the post core, periodontal surgery, and final restorations, it has become increasingly important to educate patients on the relative value of removing a questionable tooth and restoring it by means that are more predictable. The biggest challenge that the author personally sees in this process is that often the questionable tooth ends up being treated endodontically before a definitive treatment plan is completed. This usually occurs because the tooth fractured and to get the patient comfortable endodontics was necessary. Now the patient has already paid for the endodontic therapy and the clinician is in a bind of how to tell the patient that they may be better served by removing that tooth. And yet, in the long term, if the tooth is not predictable, the patient will go on to pay for the post core and for the crown only to ultimately have to pay for the removal of the tooth and its replacement. It is for these reasons that it is critical before performing endodontics on questionable teeth to consider both the structural and esthetic ramifications of whether that tooth can be predictably restored before moving forward with the decision to retain it.

## Conclusion

The purpose of this article has been to identify, as specifically as possible, what criteria are necessary at this point in time to be able to restore an endodontically treated tooth and have that restoration be both esthetic and lasting. The most structurally important of these criteria is the presence of at least a 1-mm tall ferrule on both the buccal and lingual surfaces. In addition, the use of adhesive resin cements for the post and core as well as the final restoration is critical. A brief review of the procedures that can enhance the presence of a ferrule has also been presented, specifically the use of crown lengthening or forced eruption.

One final comment on maintaining a ferrule: it is not uncommon to see an anterior tooth that may have had endodontic therapy with a very large access opening and a significant amount of internal tooth structure removed. If the tooth is now prepared for a traditional crown with 1.2 mm of facial reduction, there may be no remaining ferrule. One solution is to use a bonded all-ceramic crown without any internal core, either pressed or powder and liquid, and keep the facial reduction at 0.5 mm to 0.7 mm to retain a significant amount of tooth structure. If the root is dark, it may be bleached internally coronal to the

periodontal attachment to allow the use of a thinner, more translucent crown. This could be followed by a zirconium oxide post core with a pressed-ceramic core bonded with resin cement, which has been very successful for the author over the long term. Finally, the author hopes that this material stimulates the thought process for the clinician to present the concept of value in terms of current expenses for treatment vs long-term potential expenses for treatment so that the patient can make an educated decision in determining whether or not a tooth should be restored or removed, as opposed to the clinician feeling the pressure of having to make that decision alone.

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*Present the concept of value in terms of current expenses for treatment vs long-term potential expenses for treatment so that the patient can make an educated decision in determining whether or not a tooth should be restored or removed.*

# Continuing Education Quiz

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1. **What are the three major aspects to discuss when considering whether to restore or remove a questionable tooth that is biologically healthy?**
  - a. esthetic, periodontal, time
  - b. structural, esthetic, value
  - c. structural, periodontal, functional
  - d. esthetic, functional, time
2. **The structural issues of whether to retain or remove a tooth relate to the amount of:**
  - a. gingival inflammation.
  - b. periodontal health.
  - c. remaining tooth structure.
  - d. the patient's facial anatomy.
3. **Prior to the era of adhesive bonding, the typical goal in describing an adequate tooth preparation was:**
  - a. 1 mm of vertical height with 2° of taper.
  - b. 2 mm of vertical height with 4° of taper.
  - c. 3 mm of vertical height with 6° of taper.
  - d. 4 mm of vertical height with 8° of taper.
4. **The most common failure is a loss of retention of:**
  - a. the post and the core
  - b. the post and the crown
  - c. the core and the crown
  - d. the post, the core, and the crown
5. **In a maxillary anterior tooth, loading during excursive movements creates a compressive force on what aspect of the restoration?**
  - a. facial margin
  - b. lingual surface
  - c. gingival margin
  - d. labial surface
6. **Because of the tension that occurs with the occlusal forces, the more flexible the post, the more likely which of the following is to open up?**
  - a. the gingival margin
  - b. the lingual margin
  - c. the facial margin
  - d. the biologic width
7. **In general, how many methods exist to create a ferrule?**
  - a. 1
  - b. 2
  - c. 3
  - d. 4
8. **As a general rule, it will be necessary to have at least how much tooth exposed above the bone on both the buccal and lingual surfaces?**
  - a. 2 mm
  - b. 3 mm
  - c. 4 mm
  - d. 5 mm
9. **Classically, clinicians have spoken of wanting to maintain what crown-to-root ratio when deciding to retain a tooth or to remove it?**
  - a. 0:1
  - b. 1:1
  - c. 1:2
  - d. 2:1
10. **Because 4 mm of tooth structure is needed coronal to the bone, the tooth must be how long to have the needed dimensions for long-term success?**
  - a. 10 mm to 11 mm
  - b. 11 mm to 12 mm
  - c. 12 mm to 13 mm
  - d. 13 mm to 14 mm

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