Restoration of endodontic teeth: An engineering perspective

**Introduction**

Identifying the canals and building them to be able to instrument and obturate the tooth is necessary to clinical success. But restoration of the endodontically treated tooth is critical to long-term success. It does not matter if we can completely restore the endodontic portion of treatment if the tooth cannot be retained, and thus, we need to look at the restoration phase from an engineering perspective. What is needed to reinforce the remaining tooth so that it can manage the repetitive loading that necessitates the loading ability, so we can use this in the engineering design? This article will discuss the importance of ferrule in adhesive dentistry as well as when it was prior to dental bonding. Ferrule has long been an important factor in endodontics and has been uniformly recommended by Whitley et al, in their published study, “Fatigue loading of cast post and core: 91 percent of the specimens with a metal post failed” (Fig. 4). This repetitive loading and exposure of the obturation material results, failure of the restoration will fail. The literature supports that coronal leakage may be a major factor in failure of endodontic treatment. As previously discussed, when loaded during mastication, margins with inadequate coronal seal may demonstrate micro opening on the tension side, leading to leakage over time. This initially may be observed as recurrent decay, but as it deepens the occlusal aspect of the crown, the enamel becomes comminuted. The coronal surface is a rare occurrence. Bitter reported, “Compared to metal posts, FRC posts revealed reduced fracture resistance in vitro, along with a usually reversible failure mode” (Fig. 6). Whereas, with metal posts failure is typically allowed to be restored, as vertical root fracture is a rare occurrence. Bitter, et al. in their published study, “The risk of failure was greater with metal post crowns (nine out of 98 metal posts failed) than with carbon fiber posts (using which, none out of 97 fractures occurred)” (Fig. 7).

**Fig. 1.** Strain analysis of a posterior tooth demonstrating concentration of strain on loading at the cervical. (Image/Provided by Dr. Gene McCoy)

**Fig. 2.** As a maxillary anterior tooth is loaded during mastication, tension and compression occur at the crown’s margins. (Image/Provided by Dr. Gregory M. Kurtzman)

**Fig. 3.** Opening of the margins on the tension side may lead in time to recurrent decay or restoration and endodontic failure.

**by whichever of the materials is stiffer.**

**Dent. Trib. Middle East & Africa Ed.**

**Fig. 4.** Difference of intensity of strain and location related to ferrule height during occlusal loading (Libman).

**Fig. 5.** Comparison of load distribution of fiber post, cast metal post and prefabricated metal post.

**Fig. 6.** Tooth restored with a fiber post demonstrating coronal horizontal fracture suprastructure, typically even with teeth restored with fiber posts when unloaded.

**Fig. 7.** Vertical root fracture of a tooth restored with a metal post.

**Fig. 8.** Comparative modulus of elasticity of different post materials.

**Fig. 9.** Vertical root fracture of a tooth restored with a metal post.

The elastic modulus refers to the material’s modulus of elasticity, the stiffer the material, the higher its relative modulus. When two different materials are placed together, such as when a post is placed into a tooth’s root, the elastic modulus is influenced by whichever of the materials is stiffer. Dentin averages a modulus of elasticity of 17.5 (± 3.8) GPa, with glass fiber posts at 24.4 (± 3.4) GPa, titanium pre-fabricated posts at 66.4 (± 9.6) GPa, prefabricated stainless steel at 89.6 (± 10.7) GPa and cast high noble gold posts at 53.4 (± 4.5) GPa. Cast posts fabricated from noble or base metals have higher modulus then high noble alloys and approach stainless-steel modulus, the higher its relative stiffness. Fiber posts have
DENTAL TRIBUNE Middle East & Africa Edition | July-August 2015

an elastic modulus that more closely approaches that of dentin. Thus, use of fiber and metal posts was re-
spectively four and seven times higher for each class of post, and there is still debate on whether a post strengthens the tooth.16,17 The material post absorbs and carries stress, resulting in the coronal portion of the root. When no ferrule was present, the prefabricated metal post/composite combination generated greater cervical stress than cast post and cores. Yet, the ferrule seems to cancel cer-
cept stresses, resulting in the core of the remaining tooth structure.

Because the purpose of posts is to retaine the core, it is recommend-
that in non-cervical teeth a post be placed into each canal to allow greater cuspal flexure and load-bearing capabil-
ty to the tooth structure and has not been shown to be destructive. The plane of fibers should be parallel to the buccal cusp and the mesial cusp. These teeth will require a core buildup material on the distal portion to ensure the core of the root has not been compromised. Prefabricated posts and core buildup materials should be used to ensure long-term survival. Ferrule is continued.

< Page 6

DENTAL TRIBUNE

mCME

7

Fig. 9. Minimal tooth missing or Fig. 10. Moderate tooth missing or protrusion previously restored following endodontic treatment.

Fig. 11. Significant tooth missing or previously restored following endodontic treatment.

Fig. 12. Multiple fiber posts placed into a molar to both restore the remaining tooth structure and treat the existing tooth structure.

Conclusion

For restoration of endodonti-
cally treated tooth, a preserv-
ing view is needed to ensure long-term survival. Ferrule is often overlooked in today’s age of adhesive dentistry, but it is as critical today as it was in the past. Ferrule is recommended for all endodontic cases to affect survival of the tooth, and the literature supports use of 2.0 mm of ferrule. Ferrules are critical in maxillary anterior teeth due to the direction of load-
ing. Additionally, how we restore the remaining tooth plays a role in potential issues in the long term.

Posterior teeth gain strength when components of different rigidity are loaded, the more rigid components having a greater effect on resisting forces without distortion. This stress is concentrated when the post is the stiffer material at the post’s apical tip. The less-rigid component fails inwards while the more-rigid material carries the load. Prefabricated, stainless-steel post exhibiting a significantly lower fracture resistance at failure when compared with the prefabricated, stainless-steel post and similar to dentin.23 Whereas prefabricated, stainless-steel post exhibited a significantly lower fracture resistance at failure when compared with the fiber posts, the mode of failure of the carbon fiber post was more favorable to the remaining tooth structure when compared with the prefabricated, stainless-steel post and similar to dentin.22

the tooth, improving its strength. The absence of a cervical ferrule heightens the risk of root fractures. Cross-pin the core to the remaining of the article.

Fig. 12. Multiple fiber posts placed into a molar to both restore the remaining tooth structure and treat the existing tooth structure.

The absence of a cervical ferrule heightens the risk of root fractures. Cross-pin the core to the remaining tooth structure.