

Review Article

Revisiting Ferrule Effect in Endodontology: A Review

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ABSTRACT:

Endodontically treated teeth usually need special techniques to restore them. A ferrule is a metal ring or cap used to strengthen the end of a stick or tube. It has been proposed that the use of a ferrule as part of the core or artificial crown may be of benefit in reinforcing root-filled teeth. A review of the literature investigating this effect is presented. The literature demonstrates that a ferrule effect occurs owing to the artificial crown bracing against the dentine extending coronal to the crown margin. Overall, it can be concluded that a ferrule is desirable, but should not be provided at the expense of the remaining tooth/root structure.

Keywords Fracture resistance, endodontics, ferrule effect, Endo-crown.

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INTRODUCTION

In the quest of eliminating the microorganisms from the canal system one should also make sure that there is no extensive loss of tooth structure in the process. During the endodontic procedures diagnosis to Treatment Planning involves minimal invasive approach which includes correct diagnosis and decision making, minimal but decisively crafted access openings depending on anatomical challenges, during access opening minimal removal of dentin, cleaning and shaping of the root canal to retain as much sound dentin as possible, retention of tooth structure, performing a crown lengthening procedure to establish sound tooth margins for core/crown restorations rather than planning a tooth extraction and implant or bridge placement.¹

Successful restoration of root-filled teeth requires an elective coronal seal, protection of the remaining

tooth, restored function and acceptable aesthetics. A post-retained crown may be indicated to fulfil these requirements. However, one mode of failure of the post-restored tooth is root fracture. Therefore, the crown and post preparation design features that reduce the chance of root fracture would be advantageous. A ferrule is a metal ring or cap intended for strengthening. The word probably originates from combining the Latin for iron (ferrum) and bracelets (viriola). A dental ferrule is an encircling band of cast metal around the coronal surface of the tooth. It has been proposed that the use of a ferrule as part of the core or artificial crown may be of benefit in reinforcing root filled teeth. A protective, or 'ferrule effect' could occur owing to the ferrule resisting stresses such as functional lever forces, the wedging effect of tapered posts and the lateral forces exerted during the post insertion.²

INFLUENCE OF DENTIN THICKNESS

The influence of dentine thickness (buccal to the post space) on the resistance to root fracture has been investigated. This study used 40 extracted maxillary central incisors divided into four groups. The control group had 1mm of remaining buccal dentine. One of the test groups also had 1mm of remaining buccal dentine and a 608 bevel. The other two test groups had 2 and 3 mm of remaining buccal dentine, and no bevel. Cast post and cores were cemented into the test teeth, but no crowns were placed. The teeth then underwent compressive loading until they failed. The incorporation of a bevel produced a core that provided a metal collar. The authors concluded from their study that the incorporation of the metal collar did not increase resistance to root fracture. No significant differences were noted between the varying dentine wall thickness, although both the groups with only 1mm of dentine all failed owing to fracture rather than cement failure. This is of particular interest as different modes of failure may be easier to manage, i.e. a loose post versus a fractured root.³

PREOPERATIVE TOOTH ASSESSMENT

In assessing whether a tooth should be restored, the clinician must consider the amount of remaining supragingival tissue. In those clinical situations where there is insufficient ferrule length, even where margins are placed sub-gingivally, the clinician may consider surgical crown lengthening or orthodontic extrusion. This allows the distance between the crown margin and alveolar crest to be widened, and increases the potential ferrule length. Methods to increase ferrule length will reduce the root length and result in more tooth loss, possibly making the crown to root ratio unfavourable. Furthermore, both procedures will add to the cost of restoring the tooth, prolong treatment time and cause discomfort to the patient. The study by Al-Hazaimeh et al, suggests that the use of a resin-bonded direct post and resin core may be a preferable alternative where a ferrule cannot easily be obtained.⁴

FERRULE IN FULL COVERAGE CROWNS

The presence of ferrule in full coverage crowns supported by post and core was thoroughly investigated and well acknowledged to increase fractures resistance and fatigue cycles to failure. Einhorn et al. investigated the consequence of the ferrule features incorporation, on molar endo-crown failure resistance. Their results showed that adding ferrule to preparations increased the dentin surface available for bonding. However, there were milling limitations in reproducing the endo-crowns inner surface. Hence, it was reported that the more complex the preparation design became because of the addition of ferrule, the resultant endo-crown inner surface adaptation to the preparation seemed to reduce. They concluded that ferrule-containing endo-crown preparations revealed significantly superior failure

loads than regular endo-crown restorations; yet, there was no difference among the groups in the calculated failure stress based on existing surface area for adhesive bonding. Moreover, less occurrences of disastrous failure were detected with the Endo-crown preparations containing 1 mm of preparation ferrule design.⁵

FERRULE LENGTH

Sorensen et al., advised that as much coronal tooth as possible should be preserved, and a butt-joint margin between the core and tooth be used, i.e. minimal taper. They went on to suggest that the ferrule effect be defined as “A 360-degree metal collar of the crown surrounding the parallel walls of the dentine extending coronal to the shoulder of the preparation. The result is an elevation in resistance form of the crown from the extension of dentinal tooth structure”.⁶

The influence of ferrule length on resistance to preliminary failure was investigated by Libman et al. Preliminary failure is the propagation of a crack in or around the luting cement of the crown. Twenty-five extracted maxillary central incisors were split into five groups; a control group and four test groups. The test groups had ferrule lengths of 0.5, 1, 1.5 and 2 mm. The teeth were prepared with 1- mm-wide shoulders. The test teeth had cast post and cores cemented and the control group did not. All the teeth were restored with cast crowns. The teeth were subjected to cyclic loading until preliminary failure was detected, using a strain gauge. The control group and the teeth with 1.5- and 2-mm ferrules were found to be significantly better than the teeth with 0.5- and 1- mm ferrules in resistance to preliminary failure. The authors concluded that 1.5 mm should be the minimum ferrule length when restoring a root-filled maxillary central incisor with a post- and core-retained crown.⁷

THE FERRULE EFFECT IN VIVO

There appear to be no reports of prospective clinical investigations of the ferrule effect. A retrospective study of the survival rate of two post designs was conducted by Torbjorner et al. Their study involved reviewing the records of 638 patients, with a total of 788 posts; the patients were not examined. Seventy-two of the posts failed. Most (46 cases) failed owing to the loss of retention. It was observed that all the post fractures (six cases) occurred in teeth with a “lack of a ferrule effect of the metal collar at the crown margin area”. The remainder failed owing to root fracture. Their study did not state how many crowns surveyed had a ferrule. From the work of many authors, it has been shown that the position and length of the ferrule is of significance. Torbjorner et al. did not indicate whether these design features were recorded in the patient’s files. Furthermore, radiographs do not allow assessment of the amount of tissue remaining under a crown with a metal substructure. Therefore, it would be prudent for future

studies to make some record of the ferrule, or even consider keeping dies.⁸

Laboratory evidence shows in some circumstances that a ferrule effect occurs owing to the crown bracing against the dentine extending coronal to the crown margin. Furthermore, a significant increase in resistance to failure in single rooted teeth is observed where this dentine extends at least 1.5 mm. However, the cost of getting his support in teeth with no coronal dentine is loss of tooth tissue.²

CONCLUSION

A balance between the ferrule length obtained and the remaining root is therefore needed. These considerations are obviously best made prior to root canal treatment. If a suitable ferrule length cannot be obtained, the patient should be informed of the potential compromise. When assessing a tooth prior to root treatment and subsequent restoration with a crown (if needed), a ferrule would be desirable but not at the expense of the remaining tooth/root structure.

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