Gen Dent. 2004 Mar-Apr;52(2):143-6.

Effect of no ferrule on failure of teeth restored with bonded posts and cores.

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This study investigated how the absence of a ferrule affected the failure load of teeth that had been restored with bonded fiber posts and resin cores. There was a significant difference ($p < 0.001$) between the ferrule and nonferrule groups' load to failure. For the **ferrule group, root fracture was the predominant mode of failure; in the nonferrule group, debonding failures were predominant. (would be interesting to see what the incidence in the study how many cycles it took to debond the nonferrule group)**

: J Prosthet Dent. 2003 Apr;89(4):368-73.

Effects of post-core design and ferrule on fracture resistance of endodontically treated maxillary central incisors.

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STATEMENT OF PROBLEM: Studies concerning the effects of post-core design and ferrule on the fracture resistance of endodontically treated teeth remain controversial. PURPOSE: The purpose of this study was to investigate in vitro the effects of post-core design and ferrule on the fracture resistance of root canal treated human maxillary central incisors restored with metal ceramic crowns. MATERIAL AND METHODS: Forty-eight extracted human maxillary central incisors were endodontically treated and divided into 4 groups of 12. The following treatments were evaluated: group A: restored with metal ceramic (porcelain fused to metal [PFM]) crowns as control; group B: 2-mm ferrule/custom cast post-core/PFM crowns; group C: no ferrule/custom cast post-core/PFM crowns; and group D: 2-mm ferrule/prefabricated post and resin core/PFM crowns. Each specimen was subjected to load (N) on the lingual surface at a 135-degree angle to the long axis with a MTS 810 material testing machine until fracture at a crosshead speed of 0.02 cm/min. One-way analysis of variance and nonparametric chi-square test were used to compare the results. A significant analysis of variance result was followed by Newman-Keuls pairwise multiple comparisons ($P<.05$). RESULTS: There were significant differences among the 4 groups studied ($P<.01$). Group B had the highest fracture strength (1793.59 +/- 387.93 N). There was no significant difference among the fracture resistances of the other 3 groups (group A: 958.49 +/- 286.02 N; group C: 992.98 +/- 291.00 N; group D: 994.94 +/- 285.04 N). CONCLUSION: Within the limitations of this study, not all of the post-core structures tested improved the strength of the endodontically treated teeth. Those prepared with **a 2-mm dentin ferrule more effectively enhanced the fracture strength of custom cast post-core restored endodontically treated maxillary central incisors.**

Int J Prosthodont. 2002 Mar-Apr;15(2):175-8.

Effect of core bonding on fatigue failure of compromised teeth.

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PURPOSE: This study determined the effect of bonding a composite core on the number of load cycles to cement failure for teeth restored with complete crowns. MATERIALS AND METHODS: Ten extracted human maxillary central incisors were divided into two groups of five each. The tooth roots were at least 11 mm long, allowing an 8-mm post. Under copious irrigation, each tooth was cut to a flat plane 1 mm coronal to the buccal cementoenamel junction, perpendicular to the long axis of the tooth. The canal space was prepared to a final diameter of 1.25 mm, 8 mm deep. Each tooth was rebuilt with a 050 Parapost and Corestore. Final preparation height was 7 mm, including a 1-mm ferrule. For group 1, the core was bonded to the dentin using autocured Scotchbond Multipurpose Plus. For group 2, the core was not bonded. Following crown cementation, all teeth were subjected to a fatigue load of 4 kg at a rate of 280 cycles per minute. RESULTS: One tooth with a bonded core failed at 19,880 cycles, and the other four in this group did not fail after 100,000 cycles. All of the teeth without a bonded core failed at a cycle count of less than 100. The Mann-Whitney nonparametric test showed a significant difference between the two groups ($P < .01$). CONCLUSION: **Bonding of a composite core to dentin prior to crown cementation provided a significantly stronger crown retention under fatigue loading.**
(says to me use of amalgam cores has served its time)

Int Endod J. 2002 Jul;35(7):575-81.

The ferrule effect: a literature review.

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LITERATURE REVIEW: 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.**

J Prosthet Dent. 2000 Aug;84(2):169-79.

Effect of crown lengthening and ferrule placement on static load failure of cemented cast post-cores and crowns.

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STATEMENT OF PROBLEM: Restoration of mandibular second premolars with completely missing clinical crowns in the Kennedy Class I and II arches is costly and the risk of failure is high. Should the dentist choose crown-lengthening to allow the addition of a ferrule, despite incurring the disadvantage of

an increased crown/root ratio? PURPOSE: This in vitro study determined the combined effect of crown lengthening and placement of a ferrule on the failure resistance to static load of decoronated and restored mandibular second premolar analog teeth. MATERIAL AND METHODS: An extracted mandibular second premolar of average dimensions was selected to form molded composite root analogs and metal crowns. Ten specimens prepared with no-ferrule root and negligible axial wall lengths and 10 specimens with ferrule root, apically repositioned finish lines, were made. Cast gold alloy post and cores and complete crowns were made and cemented. Each root was placed in bone-simulating resin located 3 mm from the finish line. Crown lengthened/ferrule and no-crown lengthened/no-ferrule groups were equally subdivided, whereby 5 crowns were compressively loaded on the buccal cusp tip and 5 were compressively loaded on the mesial marginal ridge. A testing machine applied force until failure occurred. Failure loads were examined with 2-way ANOVA. Significant differences were accepted at P </=.05. RESULTS: Mean failure loads for the crown lengthened/ferrule and no-crown lengthened/no-ferrule groups were as follows: buccal load, 0.61 kN (SD +/- 0.11) and 0.83 kN (SD +/- 0.08); mesial load, 0.70 kN (SD +/- 0.08) and 1.00 kN (SD +/- 0.15), respectively. Crown lengthened/ferrule and no-crown lengthened/no-ferrule groups were significantly different (P <.001). CONCLUSION: The **combination of simulated surgical crown-lengthening and more apical crown margin placement to provide a 2-mm crown ferrule on a decoronated mandibular second premolar analog resulted in a reduction of static load failure for the restored analog tooth.**
(makes sense from a lever arm mechanics standpoint, the longer greater the C/R ratio the more load can be applied to the root)

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The influence of post length and crown ferrule length on the resistance to cyclic loading of bovine teeth with prefabricated titanium posts.

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PURPOSE: The purpose of this in vitro study was to evaluate the influence of post and ferrule length on the resistance to cyclic (fatigue) loading of teeth with prefabricated titanium posts (ParaPost) and crowns. MATERIALS AND METHODS: Ninety bovine teeth with similar dimensions were mounted in acrylic blocks with artificial silicone periodontal ligaments. Combinations of post lengths of 5 mm, 7.5 mm, and 10 mm, and ferrule lengths (i.e., the vertical dentinal overlap of the crown) of 0 mm, 1.25 mm, and 2.5 mm made up 9 different groups consisting of 10 teeth each. The posts were cemented with zinc phosphate cement. Composite-resin cores were made and crowns were cemented. Each test specimen underwent cyclic loading of 400 N with a frequency of 1 load per second at an angulation of 45 degrees to the long axis of the tooth. RESULTS: All but 2 specimens failed with a root fracture; in the remaining 2 specimens the core lost retention. A large variation in the results between the various groups was observed. A nonparametric 2-way analysis for groups with a natural order revealed that the fracture resistance to cyclic loading increased statistically significantly with increasing ferrule length (P < 0.01), whereas increasing post length did not increase fracture resistance (P = 0.44). CONCLUSION: **Ferrule length was more important than post length in increasing fracture resistance to cyclic loading of crowned teeth.**
(makes sense since we know that post length doesnt contribute to core retention as much as ferrule of the remaining tooth)

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Effect of core stiffness on the in vitro fracture of crowned, endodontically treated teeth.

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STATEMENT OF PROBLEM: Dentin and core materials that substitute for missing dentin are dissimilar materials. A core material with a lower elastic modulus may deform more under applied stress and therefore result in reduced stress concentration at the core/dentin junction. PURPOSE: This in vitro study examined the effect of core stiffness on the fracture resistance and failure characteristics of a crowned, endodontically treated tooth under simulated occlusal load. MATERIAL AND METHODS: Forty extracted human mandibular premolars were divided equally into 4 groups and prepared for posts and cast crowns as follows: **group 1 = cast post and core, cast crown; group 2 = preformed metal post, composite core, and cast crown; group 3 = preformed metal post, amalgam core, and cast crown; and group 4 (control) = preformed metal post, no core, and cast crown.** All prepared teeth had 2 mm of sound dentin on which the cemented crown rested. A continuous load (kg) was applied to the buccal cusp at a 30-degree angle to the long axis of each tooth at a crosshead speed of 2 mm/min until failure. Collected data were subjected to 1-way analysis of variance with the Welch modification to compare groups ($P<.05$). RESULTS: Failure loads for the 4 test groups were as follows: 98.1 +/- 34.6 kg (group 1), 94.4 +/- 41.8 kg (group 2), 105.5 +/- 18.6 kg (group 3), and 101.1 +/- 55.3 kg (group 4). No significant difference in failure load values was found among the 4 groups. The primary mode of failure (80%) in all groups was an oblique radicular fracture, either apical to the post or at the post level. Horizontal fracture of the root and post was found in groups 1, 2, and 3 (20%). Loosening of the crown, post, and core was found only in group 2(20%). CONCLUSION: **Within the limitations of this study, core stiffness did not affect the failure resistance of teeth restored with posts and cores and complete-coverage cast metal crowns. The dominant pattern of failure was unrepairable root fracture. Only the composite core exhibited repairable fractures.**

(shows that in this study that all metal posts whether prefabricated or cast led to unrepairable failures, unfrotunatly they didnt include a group with no post to compare)

From ROOTS discussion of Ferrule Effect and Fracture 8/12/2004