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Fracture resistance of metal-ceramic crown copings cemented to two types of intra-radicular posts

Resistência à fratura de copings de coroa metalocerâmica cimentados sobre dois tipos de retentores intrarradiculares

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Resumo

Introdução: Os dentes tratados endodonticamente são mais suscetíveis à fratura radicular do que os dentes vitais. Para reduzir o risco de fratura, indica-se o uso de coroas e retentores intrarradiculares. No entanto, ainda não está clara a resistência dessas estruturas a fraturas. **Objetivo:** Analisar o comportamento de *copings* de coroa metalocerâmica cimentados com dois tipos de retentores intrarradiculares sob tensão de tração. **Material e método:** Dezesseis *copings* de coroa metalocerâmica cimentados com cimento de fosfato de zinco para núcleos e pinos de metal fundido (grupo 1, $n = 8$) ou com cimento resinoso autoadesivo para núcleos de resina composta com pinos de fibra de vidro (grupo 2, $n = 8$) foram submetidos a testes de tração após tratamento endodôntico e preparo padronizado. Houve falha quando o *coping* da coroa e/ou a estrutura pino-núcleo se quebrou e/ou se soltou. **Resultado:** No grupo 1, após a aplicação de uma carga de tração média de 46,83 N, 7 *copings* e núcleos metálicos se separaram completamente, enquanto em 1 espécime o *coping* se soltou do núcleo metálico. No grupo 2, uma carga de tração média de 127,68 N resultou em fratura do pino de fibra de vidro, e em 1 caso toda a estrutura coroa-pino-núcleo se soltou. A resistência à tração foi significativamente diferente entre os dois grupos ($P = 0,0085$). **Conclusão:** Nossos achados sugerem que *copings* de coroa metalocerâmica cimentados com cimento resinoso autoadesivo apresentam forte adesão aos núcleos de resina composta associados aos pinos de fibra de vidro, proporcionando uma alternativa segura ao uso de retentores de metal fundido.

Descritores: Técnica para retentor intrarradicular; cimentos de resina; resistência à tração.

Abstract

Introduction: Endodontically treated teeth are more susceptible to root fracture than vital teeth. In order to reduce the risk of fracture, the use of intra-radicular posts and crowns is indicated. However, their own fracture resistance remains unclear. **Objective:** To analyze the behavior of metal-ceramic crown copings cemented to two types of intra-radicular posts under tensile stress. **Material and method:** Sixteen metal-ceramic crown copings cemented with zinc phosphate cement to cast metal posts and cores (group 1, n = 8) or with self-adhesive resin cement to glass-fiber posts rebased with composite resin (group 2, n = 8) were subjected to tensile testing after endodontic treatment and standardized preparation. Failure occurred when the crown coping and/or post-core assembly fractured and/or detached. **Result:** In group 1, after the application of a mean tensile load of 46.83 N, 7 crown copings and metal cores separated as a whole, while in 1 specimen the coping detached from the metal core. In group 2, a mean tensile load of 127.68 N resulted in glass-fiber post fracture, and in 1 case the entire crown-post-core assembly was detached. Tensile strength differed significantly between the two groups ($p = 0.0085$). **Conclusion:** Our findings suggest that metal-ceramic crown copings cemented with self-adhesive resin cement show strong adhesion to composite resin cores associated with glass-fiber posts, thus providing a safe alternative to the use of cast metal posts and cores.

Descriptors: Post and core technique; resin cements; tensile strength.

INTRODUCTION

Endodontically treated teeth are more susceptible to root fracture than vital teeth[1]. Failure tends to occur in teeth with minimal coronal structure and/or weakened roots[2-4]. The occurrence of dental caries or trauma is largely responsible for the loss of tooth structure, resulting in the need for endodontic treatment[5]. Restoration of root-filled teeth aims to increase the fracture resistance of the tooth and meet the aesthetic and functional needs of the patient[6]. In order to reduce the risk of fracture, the use of intra-radicular posts and crowns is indicated[6].

Two types of intra-radicular posts are usually employed to rehabilitate endodontically treated teeth and increase crown retention: cast metal posts and prefabricated fiber posts[7]. Restorations are subjected to repeated cyclic loads with a combination of compressive and tensile strengths during mastication[8]. Several studies have compared the two post systems with respect to their ability to reduce the risk of root fracture and have described the best techniques and protocols for use of posts, including post length and diameter and adhesive system. These studies have used different methods, such as application of oblique load and cyclic load, but all results converge positively to the same conclusion: the use of glass-fiber posts reduces the risk of root fracture, thus increasing the success of restoration[5,7,9-14]. However, many professionals who advocate the use of cast metal posts and cores raise the question of how copings for metal-ceramic crowns cemented to glass-fiber posts rebased with composite resin would behave under tensile stress.

Therefore, the purpose of the present study was to evaluate the tensile strength of metal-ceramic crown copings cemented to cast metal posts and cores or to glass-fiber posts rebased with composite resin. The hypothesis tested was that metal-ceramic crown copings cemented to glass-fiber posts rebased with composite resin would have a higher tensile strength than those cemented to cast metal posts and cores.

MATERIAL AND METHOD

Sixteen single-rooted premolars were obtained from the Oral Surgery Clinic at the Dental Department of our institution. All samples were donated by patients. The study was approved by the research ethics committee of the institution (protocol number CE/CEUS-165/2013).

After thoroughly removing all remaining tissue, the teeth were sterilized in an autoclave at 138 °C, rehydrated in 0.9% saline solution and then maintained at 37 °C for 48 hours. The crowns were removed, leaving a root length of 14 to 16 mm. The root canals were prepared with .04 taper NiTi rotary files (RaCe; FKG, La Chaux-de-Fonds, Switzerland) until a size #30 file reached the working length. The canals were filled with AH Plus sealer (Dentsply, Petrópolis, RJ, Brazil) and obturated with .04 taper gutta-percha cones (Dentsply) using the vertical condensation technique.

In all root canals, post spaces were prepared 24 hours after obturation by removing the gutta-percha with size #4 Gates-Glidden drills (Dentsply) and standardized with MaxiCut drills (#9373). Then, the teeth were randomly divided into 2 groups of 8 teeth each:

Group 1 (n = 8): the canals were restored with cast metal posts and cores fabricated from acrylic resin (Pattern Resin LS; GC America, Alsip, IL, USA) followed by an additional casting with an 80% silver alloy (Tecnofix, São Paulo, SP, Brazil), which were luted with zinc phosphate cement (SSWhite, Rio de Janeiro, Brazil);

Group 2 (n = 8): the canals were restored with Reforpost glass-fiber posts (Angelus, Londrina, PR, Brazil), which were relined with Z100 composite resin (3M, Sumaré, SP, Brazil) and luted with SmartCem 2 self-adhesive resin cement (Dentsply).

After cementing, the coronal portion of the post was reconstructed with Z100 composite resin (3M). All specimens were stored at 100% relative humidity and 37 °C for 72 hours.

Coronal access cavities were prepared using size #2135 and #3118 KG burs (KG Sorensen, Cotia, SP, Brazil). All crown copings were made of metal material and cemented with zinc phosphate cement (SSWhite), and a holder was connected to them for attachment to the testing machine. The specimens were subjected to tensile testing in a universal testing machine (Kratos, Barueri, SP, Brazil) at a crosshead speed of 0.5 mm/min. All tests were performed at the Dental Department of our institution. Failure occurred when the crown coping and/or the post-core assembly fractured and/or detached. The results from tensile strength tests were analyzed using Student's t-test with 99% confidence. The level of significance was set at $p < .05$.

RESULT

The mean tensile load until failure applied to group 1 was 46.83 N and to group 2 was 127.68 N. The specimens in group 2 failed at a significantly higher tensile load than the specimens in group 1 ($p = .0085$) (Table 1).

In group 1, 7 crown copings and metal cores separated as a whole (Figure 1), while in 1 specimen the coping became detached from the metal core. In group 2, application of tensile load resulted in glass-fiber post fracture, and in only 1 case the entire crown-post-core assembly was detached (Figure 2).

Figure 1. Cast metal post-core assemblies and copings separated as a whole after being subjected to tensile stress.

Table 1. Tensile load until failure

	Group 1 (n = 8)	Group 2 (n = 8)
Mean tensile load (N)	46.8250	127.6763
Standard deviation	27.4449	58.2605
Confidence interval (99%)	−171.7487 to 10.0462	---

Figure 2. Glass-fiber post-core assembly and coping separated as a whole after tensile testing.

DISCUSSION

Our results showed that metal-ceramic crown copings cemented to glass-fiber posts rebased with composite resin had a higher tensile strength than those cemented to cast metal posts and cores, with strong adhesion of the coping to the composite resin core. Thus, the research hypothesis was accepted. Also, the results showed that adhesion of glass-fiber posts to intracanal wall dentin using the SmartCem 2 cement was higher than that of cast metal posts and cores, as they could withstand a higher tensile load (127.68 N *vs* 46.83 N).

Metal remains the material of choice for the fabrication of posts and cores. Although new materials and adhesive cementation techniques have been developed for post-core restoration in endodontically treated teeth, there is still considerable uncertainty about the reliability and efficacy of these materials and techniques.

The use of a crown is indicated in cases of significant loss of coronal structure. In the present study, we chose to use a porcelain-fused-to-metal (PFM) crown, since this prosthesis is well accepted by dental surgeons. The use of zinc phosphate cement as a luting agent is justified by its well-known indications and properties, being a traditional and reliable choice[15]. However, questions remain about the bond strength at the post-core and post-cement interfaces.

In endodontically treated teeth, protection of the crown and root is required. The combination of a composite resin core with a glass-fiber post, when subjected to oblique loads, has been shown to protect the remaining root[9]. It has also proven to be very effective in preserving and improving the biomechanical behavior of weakened roots[10,16].

Self-etching adhesive resin cement, rather than dual-cured resin cement, was used in the present study because it is practical and easy to apply and has greater tensile strength than the dual-cured resin cement[17]. In a study evaluating the physical properties of self-etching adhesive resin cements, the results of SmartCem 2 were acceptable and satisfactory regarding its ability to maintain an acidic pH for 48 hours after cementation, amount of cement particles, viscosity, and film thickness[18].

In the present study, when crown copings were subjected to tensile stress, we examined their behavior in relation to the adhesion of luting agents (self-adhesive resin cement *vs* zinc phosphate cement) to post surface. In group 1, only one crown coping separated from the metal core, while all others remained cemented to their posts and cores. In group 2, the glass-fiber post fractured in all cases, except for one case in which the entire crown-post-core assembly was detached. These results suggest that the adhesion of the crown coping to the metal core was greater than the adhesion between the metal core and the intracanal dentin. Likewise, the adhesion between the glass-fiber post and the dentin was lower than the adhesion of the composite resin core to the coping. These findings are consistent with and support the positive results obtained in several studies evaluating the behavior of zinc phosphate cement as compared to self-adhesive resin cement for the retention of metal-ceramic crowns both *in vivo* and *in vitro*[19,20].

In group 1, the mean tensile load necessary for separating the coping and metal post-core assembly was 46.8 N, while, in group 2, a mean tensile load of 127.6 N was needed to cause post fracture. We can infer, therefore, that the adhesive luting of the metal core to the dentin with zinc phosphate cement is less strong than the adhesive luting of the glass-fiber post to the dentin with resin cement. This finding also supports the indication of glass-fiber posts for the restoration of endodontically treated teeth.

This study has some limitations. Only premolars were used in the study; therefore, future studies should consider using anterior and posterior teeth, since tooth inclination may influence the results. In future research, thermal cycling should also be used with vertical or occlusal forces, simulating mastication for at least 2 years. Finally, further studies using new cements and new technologies, such as CAD/CAM, are also warranted.

CONCLUSION

In the experimental conditions of this study, it can be concluded that metal-ceramic crown copings cemented with self-adhesive resin cement show strong adhesion to composite resin cores associated with glass-fiber posts. Therefore, the use of intracanal retainers with glass-fiber posts can provide a safe and reliable alternative to the use of cast metal posts and cores in the rehabilitation of endodontically treated teeth.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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