ORIGINAL ARTICLE

Tensile Strength of Non-Precious Gold, Cobalt-Chromium, and Fiber Posts Cemented with Panavia F2 Resin Cement in Root Canals of Endodontically-Treated Teeth

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ABSTRACT

Aim: To assess the tensile strength of non-precious gold, cobalt-chromium (Co-Cr), and fiber posts cemented with Panavia F2 resin cement in root canals of endodontically-treated teeth.

Methods: This in vitro, experimental study evaluated 30 extracted single-rooted, single-canal maxillary central incisors. The post space was prepared and the teeth were randomly divided into 3 groups (n=10) of fiber post, non-precious gold, and Co-Cr post. All posts were cemented using Panavia F2 resin cement. The tensile bond strength was measured using a universal testing machine. Data were analyzed using SPSS version 18 via ANOVA.

Results: The mean tensile bond strength was 127.05±28.96 N in fiber post, 122.62±52.80 N in Co-Cr post, and 127.48±42.62 N in non-precious gold post group. The three groups had no significant difference regarding the mean tensile bond strength (P=0.996).

Conclusion: Considering the lack of a significant difference in tensile bond strength of the three types of posts as well as the optimal esthetics, easy application, and similar modulus of elasticity of fiber posts to dentin, fiber posts cemented with Panavia F2 resin cement would be ideal for use in endodontically-treated teeth.

Keywords: Tensile Strength; Fiber Post; Non-Precious Gold Post; Cobalt-Chromium Post; Panavia F2 Resin Cement

INTRODUCTION

Restoration of endodontically-treated teeth is often challenging due to the loss of a great portion of tooth structure as the result of extensive caries, fracture, previous restorations,or access cavity preparation. Restoration of endodontically-treated teeth should preserve the remaining tooth structure, prevent coronal leakage, and provide favorable function and esthetics. However, it is often challenging to achieve, since the remaining coronal tooth structure cannot provide adequate retention and resistance for the restorative material to tolerate occlusal forces[1]. Thus, most endodontically-treated teeth require a post and core restoration in order to have acceptable function. Prefabricated and cast posts are commonly used for restoration of endodontically treated teeth that have lost a large portion of their structure[2]. However, selection of the proper type of post for this purpose may be challenging for some clinicians[1]. The selected intracanal post for this purpose should be able to meet the requirements of endodontically-treated teeth. The post space should be prepared as small as possible because excessive root dentin removal would seriously compromise the root integrity and make it susceptible to fracture[3].

Cast posts are the first type of intracanal posts and their application dates back to many years ago. Cast posts have complications such as corrosion, tooth discoloration, risk of root fracture, and difficult retrieval. Despite the introduction of many novel intracanal posts such as tooth-colored posts with favorable esthetics, and the aforementioned complications of cast posts, cast posts are still the choice of treatment for manyendodontically-treatedteeth[2]. Cast posts can be fabricated by direct or indirect methods. In indirect method of fabrication, an impression is made from the root canal, and the intracanal post is fabricated in a dental laboratory. These posts well occupy the root canal space. However, their fabrication is time-consuming and costly [3].

On the other hand, several types of prefabricated posts have been introduced to the market in the past 20 years [4]. The new generations of fiber posts have overcome some limitations of metal posts such as their esthetic shortcomings and some treatment failure modes. Use of fiber-reinforced posts is gaining increasing popularity worldwide due to favorable esthetics, optimal fatigue resistance, and reinforcing the root canal structure [5]. Unlike metal posts, fiber posts have a modulus of elasticity similar to that of dentin and therefore, enable better distribution of occlusal forces along the root and decrease the risk of irreparable root fracture [6]. Short-term and long-term results regarding clinical application of fiber posts have been promising, and they reportedly have a 7- to 11-year survival rate of 89% to 93% [7]. Despite having a modulus of elasticity similar to that of dentin and subsequently better stress distribution, treatment failure is still a matter of concern in use of fiber posts [8].

Several strategies have been proposed to enhance the bond strength of intracanal posts and minimize the rate of failures,such as the application of different cements and adhesives, and silanization to enhance the wettability of the post and enable chemical bonding of resin cement to mineral post fibers.

The significant role of tensile bond strength and retention of intracanal posts under dynamic occlusal forces in treatment success is an interesting research topic in need of further investigations [9]. Many confounding factors such as the geometry of intracanal post, the surface topography of the post in macro- and micro-scale, length and diameter of the post, and type of cement can all affect the retention and tensile bond strength of intracanal posts [10]. Loss of retention and dislodgment of intracanal posts is an important cause of failure of post and core restorations. Debonding may occur within the cement material or at the cement-tooth structure or cement-post interface[11].

Ideal cement should have optimal mechanical properties to well resist the functional loads and favorably adhere to the post surface. It should also have high stress tolerance. Thus, application of cements with elastic parameters comparable to those of root dentin that can provide optimal bond strength to the post and root dentin can result in optimal stability and retention of intracanal posts [8]. Moreover, cements with fewer procedural steps are preferred for this purpose[12]. Panavia F2 resin cement is a self-adhesive resin cement that does not require primary preparation of the tooth structure and is applied in one step after mixing. Thus, it has significantly lower rate of errors related to high technical sensitivity[13]. This study aimed to compare the tensile bond strength of non-precious gold, cobalt-chromium (Co-Cr), and fiber posts cemented with Panavia F2 resin cement in the root canals of endodontically-treated teeth.

MATERIALS AND METHODS

This in vitro, experimental study evaluated 30 sound, single-rooted, single-canal maxillary central incisors. The teeth had been extracted for purposes not related to this study. The study was approved by the ethics committee of Kermanshah University of Medical Sciences IRKUMS .REC. 13898.868.

Sample size was calculated to be 30 according to a study by Aalaei et al[9] assuming the mean and standard deviation of tensile bond strength of two types of cemented fiber posts to be 88.17±25.39 Nand 74.19±25.04 N, type 1 error of 0.05N and type 2 error of 20%. The teeth were selected using convenience sampling.

The inclusion criteria were extracted maxillary central incisors without caries, adequate and standardized root length, standardized diameter, absence of cracks, and having one single canal. Carious teeth and those with cracks, short roots, canal malformation, or extensive canals were excluded.

The eligible teeth were first immersed in 0.2% thymol solution at 4°C for 48 h for disinfection and were then rinsed and stored in saline. The teeth were decoronated using a diamond disc and a low-speed hand-piece such that the remaining root had 15 mm length. A #15 K-file (Mani, Japan) was introduced into the canal 1 mm shorter than the actual apex. The root canals were instrumented using the single-length technique to 1 mm from the apical foramen using Pro Taper rotary system (Maillefer, Switzerland) to F3 file according to the manufacturer's instructions. The root canals were rinsed with 0.5% sodium hypochlorite after each filing. Next, the root canals were filled with gutta-percha (Ariadent, Iran) and AH-26 (Dentsply Maillefer) sealer using the lateral compaction technique. Each tooth was then radiographed to ensure optimal quality of obturation. Peeso reamers #1 and 2 (Maillefer) were used for post space preparation and the gutta-percha was removed from the canal to 4 mm distance from the apex[9]. The prepared roots were then randomly divided into three groups (n=10) of fiber post (nordin made in Swiss) (n=10), non-precious gold post (made in Iran) (n=10) and Co-Cr post (made in Iran) (n=10).non precious gold posts and co-cr posts were made by direct techniqueand after casting of them they were fit in root canal space without pressure using fit cheaher. Profit size of fiber posts according to root canal space was selected. Panavia F2 resin cement (Kuraray, Japan) was used for cementation of posts in all groups.

In each group, one drop of liquid A and one drop of liquid B of the PanaviaF2 resin cement were mixed according to the manufacturer's instructions. The mixture was then applied on the internal root canal walls and after 30 s, excess material was thinned by air spray. Next, equal amounts of the two pastes were placed on the mixing pad and mixed for 40 s using a spatula. The intracanal post was dipped in the mixture and some of the mixture was also delivered into the canal. Next, the post was gently placed in the canal and seated in the desired position. After complete seating of the post, excess cement was removed by an excavator and light-curing was performed using a light curing unit (woodpecker) with a light intensity of 409 (mW/cm2) for 40 s.

The teeth were then transferred into a universal testing machine (Santam, Tehran, Iran). Load was applied at a crosshead speed of 0.5 mm/min until the intracanal post dislodged. The load at dislodgement was recorded by the machine. Maximum load causing post dislodgement was recorded in Newtons (N) as the tensile bond strength of the respective post.

Data were analyzed using SPSS version 18 (SPSS Inc., IL, USA). Normal distribution of data was evaluated using the Kolmogorov-Smirnov test.Since the data were normally distributed, the groups were compared using ANOVA. Level of significance was set at 0.05.

RESULTS

Table 1 shows the mean tensile bond strength of the three groups. ANOVA revealed no significant difference in the tensile bond strength of the three groups (P=0.996). This study compared the tensile bond strength of non-precious gold, Co-Cr, and fiber posts cemented with Panavia F2 resin cement in the root canals of endodontically-treated teeth.

Table 1: Mean tensile bond strength of the three groups in Newtons (n=10)

		Force (N)		P-value
		Mean	**SEM**	
Post	Fiber	127.05	28.96	$0.996^{\dagger}$
	Co-Cr	122.62	52.80	
	Non-precious gold	127.48	42.62	

† ANOVA

DISCUSSION

The results showed that the three groups had no significant difference regarding the mean tensile bond strength of the posts (P>0.05).

In use of intracanal posts, it is important to select a post with physical and mechanical properties comparable to those of cementum and dentin. According to Mahmoudi et al[14] type of post and adaptation of its modulus of elasticity to that of cementum and dentin can significantly affect the success of treatment. They added that irrespective of the use of cast or prefabricated post, it is the adaptation of properties of the post to those of cementum and dentin that can guarantee successful bonding of the post to root dentin.

Panavia resin cement was used for cementation of posts in the present study due to its enhanced physical properties such as high bond strength, favorable bonding to root dentin, easy application, and high popularity among dental clinicians[15]. Lall and Runu[16] reported that the bond strength of self-etch resin cements to fiber posts was higher than other cements. El-Mowafy et al[17] showed that the bond strength of resin cements was three times higher than that of phosphate cements. Bonfante et al[18] assessed the tensile bond strength of fiber posts to different cements and demonstrated that resin cements provided significantly higher tensile bond strength than glass ionomer cements. On the other hand, Abreu et al[19] showed that Panavia F2 resin cement well interacted with the surface of casting posts and provided a strong bond between the metal posts and tooth structure. Also, they showed efficiently increased bond strength to the oxide-reach surface of metal alloys. Orsi et al[20] compared the tensile bond strength of different cements to metal post and cores and showed that Panavia F2 resin cement provided the most ideal bond strength between metal posts and dentin. Thus, Panavia F2 resin cement was used in this study as well. However, it should be noted that the physical and chemical properties of a resin cement can vary depending on its composition and preparation steps[21]. Therefore, preparation of cement for all teeth in this study was performed by the same operator with the same technique to eliminate the effect of such confounding factors on the results.

The current study found no significant difference in tensile bond strength of the three types of posts. Aalaei et al[9] reported the mean tensile bond strength of fiber posts to Panavia F2 to be 175.90±40.50 Nafter acid etching and 88.17±25.39 Nwithout acid etching. They attributed this difference to the conduction of acid etching prior to the application of resin cement. Their results regarding the bond strength of fiber posts in acid-etched group was comparable to our findings. Gholami et al[22] reported that the bond strength of posts made of non-precious gold alloy was significantly higher than that of posts made of chromium alloys under similar conditions. Their results were same from our findings since Sahmali et al[23] compared the tensile bond strength of metal posts and tooth-colored posts cemented with different cements. They reported that Panavia F2 resin cement yielded the highest tensile bond strength for all post types. Also, fiber posts showed lower tensile bond strength than metal posts and higher tensile bond strength than ceramic posts. The reason for high tensile bond strength of fiber posts than metal posts was maybe chemical bond of panavia f2 resin cement and fiber post. And the reason for high tensile bond strength of metal post than fiber post was maybe the better adaptation of metal post with root canal space.

The non-precious gold alloy posts have a surface topography and performance almost comparable to yellow gold alloy posts, but are less costly. They can be easily fabricated and have high durability, strong mechanical properties, high thermal resistance, excellent fit, optimal polishability, and favorable biocompatibility[24]. Fiber posts have a tensile bond strength comparable to cast posts and can be suitable for use considering their optimal esthetics, high fatigue resistance[5], and having a modulus of elasticity similar to that of dentin[6]. Ferrari et al[7] demonstrated that fiber posts have a 7- to 11-year survival rate of 89% to 93%. Co-Cr alloy has a long history of use in dental prostheses and in fabrication of intracanal posts. Co-Cr posts have excellent mechanical properties, high corrosion resistance, and favorable biocompatibility[4].

Casting and prefabricated metal posts have adequately high tensile strength. Nonetheless, their retrievable would be difficult if retreatment is required. Also, their modulus of elasticity is different from that of dentin, which would lead to formation of micro-cracks and vertical root
Fracture[25,26]. Thus, fiber posts seem to be an optimal alternative to casting and metal posts. Limited studies are available on this topic, which highlights the significance of this study.

Considering the role of confounders such as post geometry, surface properties of post in macro- and micro-scale, and length and diameter of posts in the results, all of these tried to be similar for all three types of posts. Also, the debonding interface should be microscopically evaluated in future studies to determine the mode of failure. Moreover, future studies should try to simulate the oralenvironment as much as possible to increase the generalizability of the results to the clinical setting.

CONCLUSION

Considering the lack of a significant difference in tensile bond strength of the three types of posts,as well as the optimal esthetic properties, easy application, and similar modulus of elasticity of fiber posts to dentin, fiber posts cemented with Panavia F2 resin cement would be ideal for use in endodontically-treated teeth.

REFERENCES

1. Fernandes AS, Shetty S, Coutinho I. Factors determining post selection: a literature review. The Journal of prosthetic dentistry. 2003 Dec 1;90(6):556-62.
2. Shillingburg HT, Sather DA, Wilson EL, Cain JR, Mitchell DL, Blanco LJ. Fundamentals of fixed prosthodontics. Chicago: Quintessence Publishing Co." 2012
3. Torabinejad M, Walton RE, Fouad A. Endodontics-e-book: Principles and practice. Elsevier Health Sciences; 2014 Jul 16. Page.67
4. Xin XZ, Xiang N, Chen J, Wei B. In vitro biocompatibility of Co–Cr alloy fabricated by selective laser melting or traditional casting techniques. Materials Letters. 2012 Dec 1;88:101-3.
5. Singh A, Logani A, Shah N. An ex vivo comparative study on the retention of custom and prefabricated posts. Journal of conservative dentistry: JCD. 2012 Apr;15(2):183.
6. Rathke A, Haj-Omer D, Muche R, Haller B. Effectiveness of bonding fiber posts to root canals and composite core build-ups. European journal of oral sciences. 2009 Oct;117(5):604-10.

7. Ferrari M, Cagidiaco MC, Goracci C, Vichi A, Mason PN, Radovic I, Tay F. Long-term retrospective study of the clinical performance of fiber posts. American journal of dentistry. 2007 Oct 1;20(5):287.
8. Mosharraf R, Haerian A. Push-out bond strength of a fiber post system with two resin cements. Dental research journal. 2011 Dec;8(Suppl1):S88.
9. Aalaei S, KalbasiAnaraki S, RezaeiAdli A, Rouhi N. Comparison of Tensile Strength of Three Resin Cements in Root Canal Treatment: Panavia F2. 0, Clearfil SA, and Relyx U200. Journal of Mashhad Dental School. 2019;43(1):1-9.
10. Xu ZT, Peng LF, Lai XM, Fu MW. Geometry and grain size effects on the forming limit of sheet metals in micro-scaled plastic deformation. Materials Science and Engineering: A. 2014 Aug 12;611:345-53.
11. Pereira JR, da Rosa RA, do Valle AL, Ghizoni JS, Só MV, Shiratori FK. The influence of different cements on the pull-out bond strength of fiber posts. The Journal of prosthetic dentistry. 2014 Jul 1;112(1):59-63.
12. Faria-e-Silva AL, Menezes MD, Silva FP, Reis GR, Moraes RR. Intra-radicular dentin treatments and retention of fiber posts with self-adhesive resin cements. Brazilian Oral Research. 2013 Feb;27(1):14-9.
13. Monticelli F, Ferrari M, Toledano M. Cement system and surface treatment selection for fiber post luting. Medicina Oral Patologia Oral y CirugiaBucal. 2008 Mar 1;13(3):214.
14. Mahmoudi M, GandjalikhanNassab SA, Saidi A, Hashemipour M. The Effect of Dimension and Geometrical Shape of Prefabricated Post and the Material of Crown on the Stress Levels and Distributions in the Root of Restored Molar Tooth Using Finite Element Method. Journal of Dentistry. 2011 Dec 1;12(4):78-84.
15. Abreu A, Loza MA, Elias A, Mukhopadhyay S, Looney S, Rueggeberg FA. Tensile bond strength of an adhesive resin cement to different alloys having various surface treatments. The Journal of prosthetic dentistry. 2009 Feb 1;101(2):107-18.
16. Lall S, Runu R. The effect of different cementation strategies on the pull-out bond strength of fiber post: an ex-vivo study. Int J Sci Rep. 2016 Apr;2(4):68-73.
17. El-Mowafy OM, Fenton AH, Forrester N, Milenkovic M. Retention of metal ceramic crowns cemented with resin cements: effects of preparation taper and height. The Journal of prosthetic dentistry. 1996 Nov 1;76(5):524-9.
18. Bonfante G, Kaizer OB, Pegoraro LF, Valle AL. Tensile bond strength of glass fiber posts luted with different cements. Brazilian oral research. 2007 Jun;21(2):159-64.
19. Abreu A, Loza MA, Elias A, Mukhopadhyay S, Rueggeberg FA. Effect of metal type and surface treatment on in vitro tensile strength of copings cemented to minimally retentive preparations. The Journal of prosthetic dentistry. 2007 Sep 1;98(3):107-18.
20. Orsi IA, Varoli FK, Pieroni CH, Ferreira MC, Borie E. In vitro tensile strength of luting cements on metallic substrate. Brazilian dental journal. 2014;25(2):136-40.
21. Pace LL, Hummel SK, Marker VA, Bolouri A. Comparison of the flexural strength of five adhesive resin cements. Journal of Prosthodontics. 2007 Jan;16(1):18-24.
22. Gholami F, Kohani P, Aalaei S. Effect of nickel-chromium and non-precious gold color alloy cast posts on fracture resistance of endodontically treated teeth. Iranian endodontic journal. 2017;12(3):45-9.
23. Sahmali S, Demirel F, Saygili G. Comparison of in vitro tensile bond strengths of luting cements to metallic and tooth-colored posts. Int J Periodontics Restorative Dent. 2004 Jun;24(3):256-63.
24. Fu G, Deng F, Wang L, Ren A. The three-dimension finite element analysis of stress in posterior tooth residual root restored with postcore crown. Dental Traumatology. 2010 Feb;26(1):64-9.
25. Öztürk C, Polat S, Tunçdemir M, Gönüldaş F, Şeker E. Evaluation of the fracture resistance of root filled thin walled teeth restored with different post systems. Biomedical journal. 2019 Feb 1;42(1):53-8.
26. Prasad R. Progress in Investment Castings, Science and Technology of Casting Processes." (2012)