The Role of the Diameter of the Titanium, Fiber and Zirconium Posts

VesnaJurukovska Shotarovska, BiljanaKapusevska, Nikola Dereban

[1]Faculty of dentistry, University "St. Cyril and Methodicus", Majka Tereza, Skopje, Republic of Macedonia

[2]PHO ''D-r. Dereban'', Struga, 6330, Republic of Macedonia

Abstract

The goal is to compare the strength of a fracture among titanium, fiber and zirconium posts. We have formed three group: titanium, fiber and zirconium,, and each group has 20 samples with 3 different diameters.

The posts were tested using "Shimadzu Univerzal Testing Mashine" at the same distance, and the force was applied to all at the same place. The fracture strength was registered on a special software system.

Between posts with the same diameter (1.2 mm) the greatest average fracture force has titanium posts 161.69 N (± 0.07), followed by fiber posts 45.38N (± 0, 01) and zirconium posts 34.81N (± 0.01). between the subgroups of the same diameter (1.35mm), the greatest average fracture strength has the titanium posts 165.26N (± 0.01), followed by the fiber posts 71.57N (± 0.01) and zirconium posts 46.53N (± 0.004). between the subgroups of the same diameter (1.5 mm) the largest average fracture force has titanium posts 202.42N (± 0.01), followed by fiber posts 73.67N (± 0.004) and zirconium posts 67.15N (± 0.004).

The diameter of the different types of posts gives different mechanical properties that affect differently the resistance of the fracture strength.

Indexing terms/Keywords: Diameter, Titanium, Fiber, Zirconium.

Subject Classification: Medical Subject Classification.

Type (Method/Approach): Bending Test.

Date of Publication: 2018-08-30

DOI: https://doi.org/10.24297/jab.v11i1.7603

ISSN: 2347-6893

Volume: 11 Issue: 01

Journal: Journal of Advances in Biology

Publisher: CIRWORLD

Website: https://cirworld.com

Introduction

The need for better aesthetics and biocompatibility of restoration contributed to finding translucent non-metallic upgrading systems and their improvement. [1] Prefabricated fiber and zirconium upgrading systems have been examined to meet the aesthetic needs of endodontically treated teeth. The transparency of fully ceramic crowns can be successfully met with the use of newly shaped fibers and ceramic posts. [2]

Their physical characteristics differently affect the surrounding tooth structure when they are cemented in the endodontically treated root canal. Different elastic modul compared to dentine allow a different transmission of load forces that can lead to root fractures of the tooth.

Reconsidering the numerous literatures and scientific knowledge that emphasize the role and mechanical properties of the different types of posts for the restoration of a single-dwelling superstructure complex as a substructure of fixed-projection structures, we set the goals of this experimental examination.

To compare the strength of a fracture among titanium, fiber and zirconium posts.

To make comparisons:

1)between different posts with the same diameter

2)What is the diameter affection - whether there is a significant difference between the groups and in which groups

Materials and Methods

To accomplish the given goals of the experimental study we use different types of posts: titanium, fiber and zirconium.

We have formed three groups, and each group has 20 samples.

I – group: Titanium posts –d1=1,2mm-20samples; d2=1,35mm-20samples; d3=1,5mm-20samplesfrom the company „Nordin"-Switzerland (Figure. 1).

II - group: fiber posts- d1 =1,2mm - 20 samples; d2 =1,35mm- 20 samples; d3 = 1,5mm-20 samples from the company "Nordin" - Switzerland (Figure 2).

III - group: zirconium post d1 = 1,2mm-20 samples; d2 = 1,35mm-20 samples; d3 = 1,5mm-20 samples from the company "Nordin" -Switzerland (fig.3).

In each of the three groups, depending on the diameter of the examined kittens, they were divided into three subgroups. A total of 180 posts were examined.

All examined posts are factory ready-made posts, of which fiber posts and zirconium posts are smooth, while titanium posts are with rough surface.

Figure 1. Titanium posts

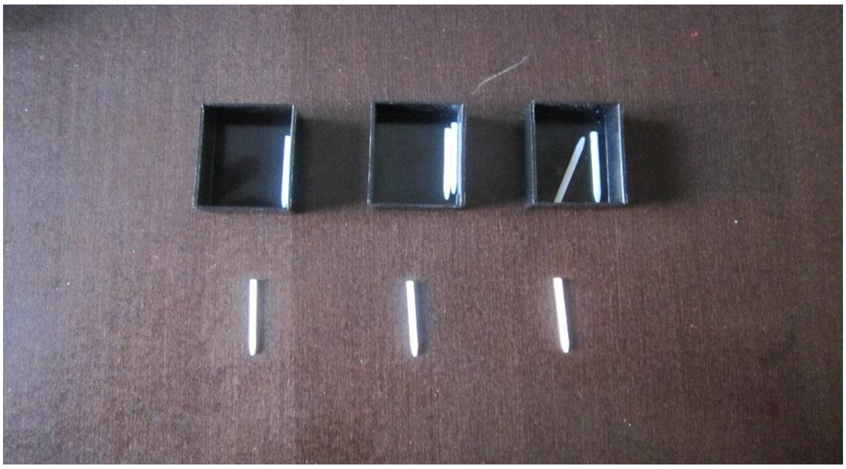

Figure 2.Fiber posts

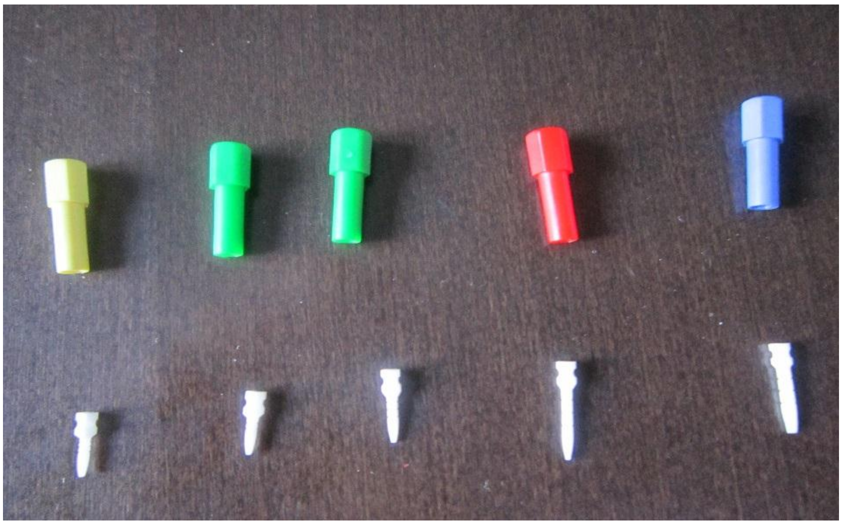

Figure.3. Zirconium posts

We put the tested posts in a water bath for two weeks, after which they were prepared for experimental testing. For the test we used a specially made base on which posts were placed. The tests carried out at the Faculty of Mechanical Engineering were tested with a universal testing machine "Shimadzu Univerzal Testing Mashine" (fig.4). The posts were placed at the same distance, and the force was applied to all at the same place. The pin speed is 0.5 mm / min. The fracture strength was registered on a special software system connected to the "Shimadzu" machine. For testing, we used the so-called "three-point bending test" - flexural bending test.

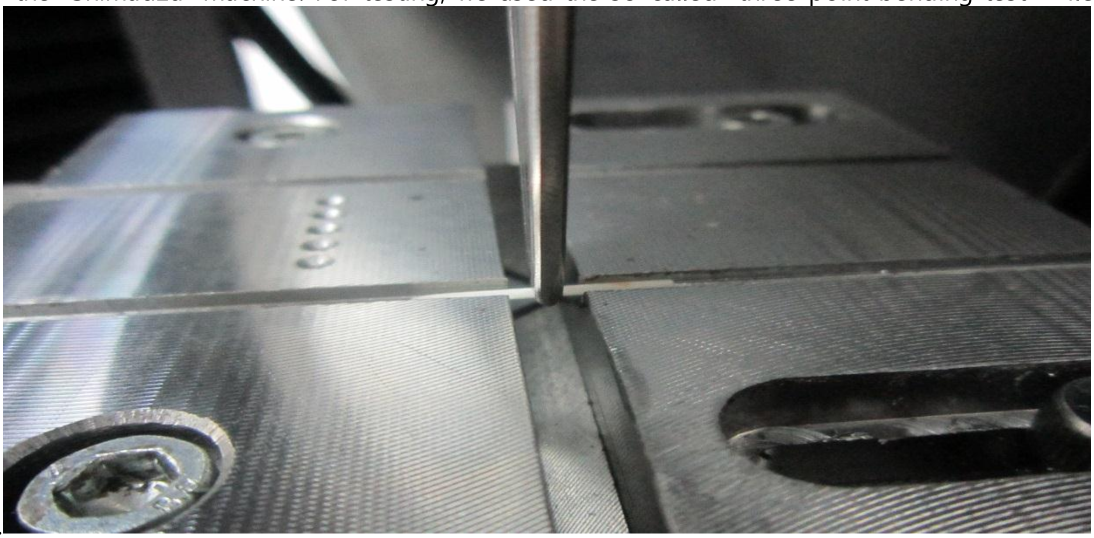

Figure 4. Three-point bending test

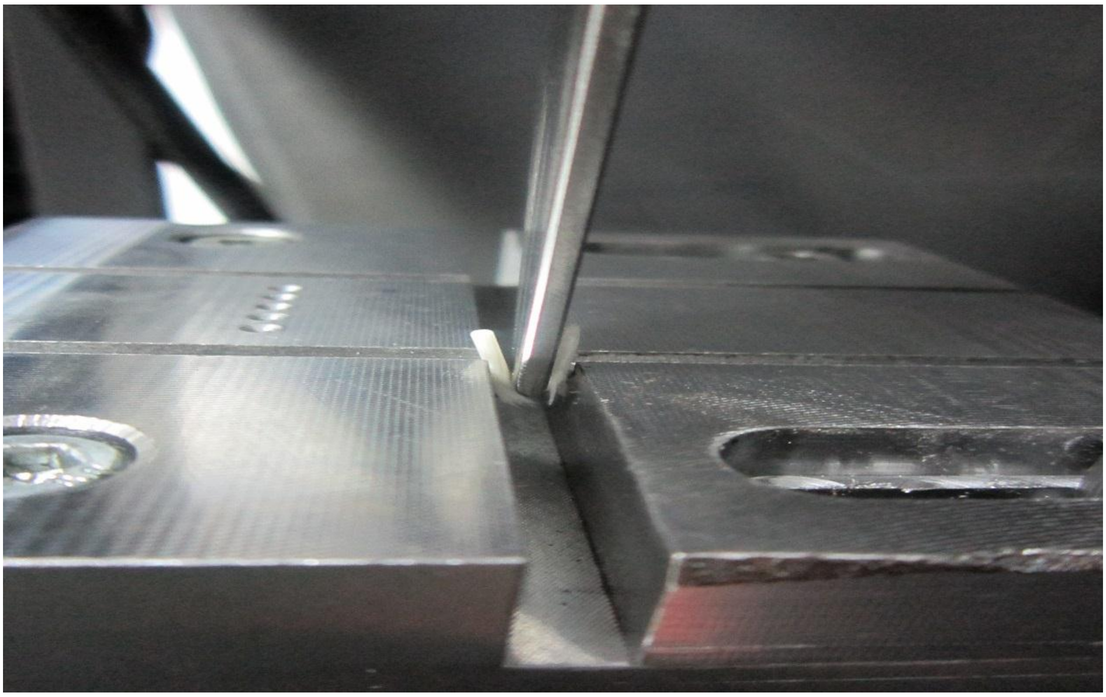

Figure 5. Three-point bending test

Results and Discussion

This section may be divided into subsections or may be combined. **Comparative force of a fracture of posts of different material with diameter d = 1.2mm**

This part of the analysis refers to testing the difference in the force of the fracture between the subgroups of posts made of different material but with the same diameter of d = 1.2 mm.

Table 1. Descriptive analysis of the strength of a fracture of packs of different material with diameter d = 1,2mm

Fracture force			
Subgroups	**Titanium posts** D = 1,2mm	**Fiber posts** D = 1,2mm	**Zirconium posts** D = 1,2mm
Means	161,6880	45,3790	34,8090
Std.Dev.	0,07150	0,00510	0,00624
Std.Err.	0,02261	0,00161	0,00197
Minimum	161,5750	45,3690	34,7980
Maximum	161,8180	45,3870	34,8210
Confidence - 95%	161,6369	45,3754	34,8045
Confidence + 95%	161,7391	45,3826	34,8135

The descriptive analysis shown in Table 1 indicates that between the subgroups of the same diameter (1.2 mm) the greatest average fracture force has titanium posts 161.69 N (± 0.07), followed by fiber posts 45.38N (± 0, 01) and zirconium posts 34.81N (± 0.01).

A comparison was made of the fracture strength of the three subgroups of pockets of diameter d = 1.2 mm, made of titanium, fiber and zirconium. Using the t-test for two independent samples, a statistically significant difference was found between the force of a fracture in subgroups with titanium and fiber posts for t = 5131.390N; df = 18 and p = 0.000; statistically significant difference between the force of the fracture in the subgroups of titanium and zirconium posts for t = 5590.716N; df = 18 and p = 0,000 and a statistically significant difference between the force of the fracture in subgroups with fiber and zirconium posts for t = 4149,443N; df = 18 and p = 0.000.

Comparison of fracture force of posts of different material with diameter d = 1.35mm

Subgroups of 60 posts with the same diameter of d = 1.35 made of three different types of material, titanium, fiber and zirconium were tested in terms of the difference in fracture strength. The derived descriptive analysis shown indicates between the subgroups of the same diameter (1.35mm), the greatest average fracture strength has the titanium posts 165.26N (± 0.01), followed by the fiber posts 71.57N (± 0.01) and zirconium posts 46.53N (± 0.004).

Table 2. Descriptive analysis of the strength of a fracture of posts of different material with diameter d = 1.35mm

Fracture force			
Subgroups	**Titanium posts** D = 1,35mm	**Fiber posts** D = 1,35mm	**Zirconium posts** D = 1,35mm
Means	165,2639	71,5650	46,5310
Std.Dev.	0,006707	0,005598	0,004346
Std.Err.	0,002121	0,001770	0,001374
Minimum	165,2530	71,5540	46,5220
Maximum	165,2750	71,5750	46,5390
Confidence - 95%	165,2591	71,5610	46,5279
Confidence + 95%	165,2687	71,5690	46,5341

Comparison of fracture force of posts of different material with diameter d = 1.5 mm

Subgroups of titanium, fiber and zirconium posts of the same diameter of d = 1.5 were tested for the difference in the strength of the fracture. The derived descriptive analysis shown indicates that between the subgroups of the same diameter (1.5 mm) the largest average fracture force has titanium posts 202.42N (± 0.01), followed by fiber posts 73.67N (± 0.004) and zirconium posts 67.15N (± 0.004).

Table 3. Descriptive analysis of the force of the fracture of posts of different material with diameter d = 1.5mm

Fracture force			
Subgroups	**Titanium posts** D = 1,5mm	**Fiber posts** D =1,5mm	**Zirconium posts** D = 1,5mm
Means	202,4172	73,6709	67,1539
Std.Dev.	0,00671	0,00458	0,00441
Std.Err.	0,00212	0,00145	0,00139
Minimum	202,4124	73,6676	67,1507
Maximum	202,4220	73,6742	67,1571
Confidence - 95%	202,4124	73,6676	67,1507
Confidence + 95%	202,4220	73,6742	67,1571

A comparison was made between the force of the fracture of the three subgroups of posts of diameter d = 1.5 mm, made of titanium, fiber and zirconium. Using the t-test for two independent samples, a statistically significant difference was found between the force of the fracture in the subgroups with titanium and fiber posts for t = 50093,35N; df = 18 and p = 0.000; statistically significant difference between the force of the fracture in the subunits of titanium and zirconium posts for t = 53259,87N; df = 18 and p = 0,000 and a statistically significant difference between the force of a fracture in subgroups with fiber and zirconium posts for t = 3241,44N; df = 18 and p = 0.000.

A comparison was made of the fracture strength of the three subgroups of posts of diameter d = 1.2 mm, made of titanium, fiber and zirconium. Using the t-test for two independent samples, a statistically significant difference was found between the force of a fracture in subgroups with titanium and fiber posts for t = 5131.390N; df = 18 and p = 0.000; statistically significant difference between the force of the fracture in the subgroups of titanium and zirconium posts for t = 5590.716N; df = 18 and p = 0,000 and a statistically significant difference between the force of the fracture in subgroups with fiber and zirconium posts for t = 4149,443N; df = 18 and p = 0.000.

A comparison was made between the force of the fracture of the three subgroups of posts of diameter d = 1.35mm, made of titanium, fiber and zirconium. Using the t-test for two independent samples, a statistically significant difference was found between the force of a fracture in subgroups of titanium and fiber posts for t = 33916.34N; df = 18 and p = 0.000; statistically significant difference between the force of a fracture in the subgroups of titanium and zirconium posts for t = 46978,18N; df = 18 and p = 0,000 and a statistically significant difference between the force of the fracture in the subgroups of fiber and zirconium posts for t = 11170,75N; df = 18 and p = 0.000. A comparison was made between the force of the fracture of the three subgroups of posts of diameter d = 1.5 mm, made of titanium, fiber and zirconium. Using the t-test for two independent samples, a statistically significant difference was found between the force of the fracture in the subgroups with titanium and fiber posts for t = 50093,35N; df = 18 and p = 0.000; statistically significant difference between the force of the fracture in the subgroups of titanium and zirconium posts for t = 53259,87N; df = 18 and p = 0,000 and a statistically significant difference between the force of a fracture in subgroups with fiber and zirconium posts for t = 3241,44N; df = 18 and p = 0.000.

The diameter of the post and the remaining dentin also play a major role in preventing a fracture of the root. Several In Vitro studies have confirmed the importance of the remaining tooth structure considering the strength and resistance of the root fracture. [3-4]

When the post diameter increases, the surface of the post when in contact with the tooth increases (5). According to some studies, increasing the diameter of the post does not significantly affect the retention capacity (6). However, it can increase the strength of the post and thus increase the risk of a root fracture. [7,8]

On the other hand, it was recommended not to use a post with a diameter below 1.3 mm because weaker posts can not provide sufficient stability. [9] One opinion is that the width of the post should not be greater than one third of the width of the root in its narrowest dimension, bearing in mind that the preservation of the remaining dentin is very important. [10]. The loss of retention appears to be the most common type of damage to the restored tooth with a post, with a damage rate of 9% [11,2]. According to other literature findings, the diameter of the post and the fracture strength have a significant influence on the survival of a fixed prototype construction (13, 14). The diameter of the post affects the fracture resistance (15,).

Conclusions

The strength of the fracture was tested on titanium, fiber and zirconium posts with a diameter of 1.2, 1.35 and 1.5 mm. Studies have shown that the diameter of the different types of posts gives different mechanical properties that affect differently the resistance of the fracture strength. With this we concluded that the different material of the posts gives significant differences in the resistance of fractures to the post.

The largest diameter of the posts significantly increases the resistance of fractures in relation to the smaller two diameters used in the experimental study.

Conflicts of Interest

There were no conflicts of interest in the preparation of this study.

Funding Statement

The students were funded from the authors' personal account and budget.

Acknowledgments

This unnumbered section is used to identify people who have aided the authors in accomplishing the work presented and to acknowledge sources of funding. The institutions that helped with the preparation of this scientific paper are as they follow:

1. Faculty of dentistry, University "St. Cyril and Methodicus", Skopje, Republic of Macedonia.

2. Department of prosthodontics, Public Health Clinic ''St. Panteleimon, Skopje, Republic of Macedonia

References

[1] Sorensen JA, Engelman MJ. Ferrule design and fracture resistance of endodontically treated teeth. J Prosthet Dent 1990; 63:529-536.

[2] Jovanovski S., Assessment of the influence of surface treatment of ceramic superstructures and their effect on fractural resistance to endondontically treated teeth, Skopje, 2012, 102-124.

[3] Guzy GE, Nicholls JI. In vitro comparison of intact endodontically treated teeth with and without endo-post reinforcement. J Prosthet Dent 1979;42;39-44.

[4] Lang H, Korkmaz Y, Schneider K, Raab WH-M. Impact of endodontic treatments on the rigidity of the root. J Dent Res 2006;85:364-368.

[5] Standlee JP, Caputo AA, Hanson EC. Retention of endodontic dowels: effects of cement, dowel length, diameter, and design. J Prosthet Dent 1978; 39:400-405.

[6] Nergiz I, Schmage P, Özcan M, Platzer U. Effect of length and diameter of tapered posts on the retention. J Oral Rehabil 2002; 29:28-34.

[7] Lambjerg-Hansen H, Asmussen E. Mechanical properties of endodontic posts. J Oral Rehabil 1997; 24:882-887.

[8] Larato DC. Single unit cast post crown for pulpless anterior tooth roots. J Prosthet Dent 1966; 16:145-149.Sahafi A, Peutzfeldt A, Asmussen E, Gotfredsen K. Retention and failure morphology. of prefabricated posts. International Journal of Prosthodontics. 2004; 17:307–12.

[9] Zicari F, Van Meerbeek B, Scotti R, Naert I. Effect of fibre post length and adhesive strategy on fracture resistance of journalofdentistry 41(2013) 1020–1026endodontically treated teeth after fatigue loading. Journal of Dentistry. 2012; 40:312–21.

[10] Bouillaguet S, Troesch S, Wataha JC, Krejci I, Meyer JM, Pashley DH. Microtensile bond strength between adhesive cements and root canal dentin. Dental Materials. 2003; 19:199–205.

[11] Farina AP, Cecchin D, Barbizam JV, Carlini-Junior B. Influence of endodontic irrigants on bond strength of a self-etching adhesive. Australian Endodontic Journal. 2011; 37:26–30.

[12] Lindblad RM, Lassila LV, Salo V, Vallittu PK, Tjaderhane L. One-year effect of chlorhexidine on bonding of fibre-reinforced composite root canal post to dentine. Journal of Dentistry. 2012; 40:718–22.

[13] Huber L, Cattani-Lorente M, Shaw L, Krejci I, Bouillaguet S. Push-out bond strengths of endodontic posts bonded with different resin-based luting cements. American Journal of Dentistry. 2007;20:167–72.

[14] Schirrmeister JF, Kielbassa AM. Coronal leakage of calcium phosphate-based root canal sealers compared with usual sealers. SchweizerMonatsschriftfu¨ r Zahnmedizin. 2006; 116:224–8.

[15] Amirouche-Korichi A, Mouzali M, Watts DC. Effects of monomer ratios and highly radiopaque fillers on degree of conversion and shrinkage-strain of dental resin composites. Dental Materials. 2009;25:1411–8.