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# The Effect of the Use of Different Types of Cement and Zirconium Post Systems on Endondontically Treated Teeth

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**Abstract**

**BACKGROUND:** Prefabricated zirconium upgrading systems were examined to satisfy aesthetic needs in endodontically treated teeth. Endodontically treated teeth, together with non-metallic posts and superstructure, are substructures that enable the production of prosthetic structures that will allow aesthetics, resulting from normal light transmission. To investigate and analyse the retention of zirconium post systems cemented with RelyX Unicem 2 Automix (RLX) cement with Pull-out test.

**AIM:** To examine the retention of zirconium post systems, cemented with Multi-Link Automix (MLA) cement and RelyX Unicem 2 Automix (RLX) cement with Pull-out test.

**MATERIAL AND METHODS:** In this study were used, 120 post systems of the company ZIRIX NORDIN - Switzerland, with different diameters d1 = 1.2, were used: d2 = 1.35, d3 = 1.5, and two types of resin cements: Multilink Automix-Ivoclar (MLA), and RelyX Unicem 2 Automix (RLX) - 3 M ESPE.

**RESULTS:** The analysis of the extraction force in newtons (N) zirconium post systems of Multilink Automix cement according to subgroups of three diameters is consequently 481.3 ± 1.9 vs 462.9 ± 4.5 vs 454.2 ± 2.2. The analysis of the extraction strength in the newtons (N) zirconium post systems of RelyX Unicem 2 Automix cement in the entire sample is 577.9 ± 6.1 N.

**CONCLUSION:** The largest diameter of the posts significantly increases the resistance of fractures compared to the smaller two diameters used in the experimental study.

## Introduction

The new concepts of non-metallic restoration have led to the development of modern materials and methods for postendodontic treatment of endodontically treated teeth [1] [2]. Endodontically treated teeth, together with non-metallic posts and superstructure, are substructures that enable the production of prosthetic structures that will allow aesthetics, resulting from normal light transmission [3] [4].

Several new methods have been developed in aesthetic dentistry, including new composite materials, dentin adhesives and non-metallic post systems. After the definite endodontic treatment of the root canal, it is necessary to build upgrading systems for retention and support definite prosthetic restoration [5]. Paradental and endodontic status, root length, and the histological structure of devitalized teeth must be considered to achieve a successful fixed-prosthetic restoration [6] [7].

Endodontically treated roots restored by metal superstructure systems are more subjected to fractures due to the high elastic modulus compared to tooth dentine. Because of this, the aesthetic properties of these superstructure systems are limited

due to unsatisfactory aesthetics in the cervical part of the tooth [8].

Prefabricated zirconium upgrading systems were examined to satisfy aesthetic needs in endodontically treated teeth [9]. From this, it follows that the transparency of fully ceramic crowns can be successfully satisfied with the use of ceramic post systems. Zirconium post systems have good mechanical properties and provide specific protection of the tooth structure. This is due primarily to the minimal preparation and adhesive technique [10]. The purpose of this in vitro study is the adhesion of zirconium posts with two types of resin cement.

This arose the need for identification of the process of interphase extraction and resistance to dislocation of zirconium post systems with resinous materials. The objectives of this research arose from aesthetics as an important factor in everyday dental practice and the need for a long-term solution in teeth with a large coronary structure loss: to investigate and analyze the retention of zirconium post systems cemented with RelyX Unicem 2 Automix (RLX) cement and to examine the retention of zirconium post systems, cemented with Multi-Link Automix (MLA) cement.

## Materials and Methods

In this study, 120 post systems of the company ZIRIX NORDIN-Switzerland, with different diameters d1 = 1.2, were used; d2 = 1.35; d3 = 1.5, and two types of resin cements: Multilink Automix-Ivoclar (MLA), and RelyX Unicem 2 Automix (RLX) - 3 M ESPE.

Three subgroups were formed:

Subgroup I: 40 zirconium post systems with diameter d1 = 1.2;

Subgroup II: 40 zirconium post systems with diameter d2 = 1.35;

Subgroup III: 40 zirconium post systems with diameter d3 = 1.5.

To perform the test, extracted incisors were used with removed paradontal tissues with coriets, and the teeth were then stored in distilled water. The coronary part of the teeth was removed using special saws and the pulp with special instruments. Then, the endodontic channels were washed using a NaOCl solution, EDTA and rinsed with water and dried. In each of the samples, zirconium post systems with different diameters were applied. Then they were cemented with two types of resinous cement (Figure 1). Smooth cement was polymerised with an ice-light for light polymerization. Then the samples were stored in the Ringer's solution for seven days. The prepared samples were placed in unified acrylate blocks (Figure 2). On the prepared samples, the so-called Pull-out test - extraction test was performed on the universal testing machine Shimadzu Universal Testing Machine. The maximum force was measured in Newtons (N).

*Figure 1: Zirconium post systems, cemented in endodontically treated teeth*

The pull-out test was performed at a rate of 1 mm/min. The extraction threshold is defined as the point at which the samples can no longer stand the increase of the extraction strength.

*Figure 2: Zirconium post systems, cemented in acrylic blocks*

## Results

Zirconium post systems cemented with two types of cement RelyX Unicem 2 Automix cement and Multilink Automix, according to the three different diameters, were analysed regarding the regular/ irregular distribution of the obtained values for the pulling force expressed in newtons (N).

### *Analysis of zirconium post systems of RelyX Unicem 2 Automix cement in the three diameters*

The analysis of the extraction strength in the newtons (N) zirconium post systems of RelyX Unicem

2 Automix cement in the entire sample is 577.9 ± 6.1 N. The minimum or maximum value of the extraction force in Newtons was 565.2 vs 590.3 N. In 50% of the post systems in the entire sample, the pulling power was less than 580.1 N Table 1.

The analysis of the extraction force in the newtons (N) of zirconium post systems cemented with RelyX Unicem 2 Automix cement according to the three subgroups of diameters is consequently 581.6 ± 4.6 vs 581.4 ± 0.7 vs 570.9 ± 6.1. In the subgroup I (d1 = 1.2 mm) zirconium post systems, the minimum, i.e. the maximum value of the pullout force is 575.2 vs 590.3 N, with 50% of the post systems with a pullout force of less than 580.8 N The zirconium post systems in Subgroup II (d2 = 1.35 mm) have a minimum or a maximum value of the pulling power of 580.1 vs 582.2N, with 50% of post systems where the pulling power was less than 581.6 N. In zirconium post systems in Subgroup III (d3 = 1.5 mm), the minimum or maximum value of the pull out force would be 565.2 v.s 576.4 N, with 50% of post systems where the pullout force was less than 571.2 N.

**Table 1: Extraction force of zirconium post systems RelyX Unicem 2 Automix cement by subgroups according to the diameter**

| | | | | | 95% Confidence Interval for Mean | | | |
|---|---|---|---|---|---|---|---|---|
| Subgroups | N | Mean | Std. Deviation | Std. Error | Lower Bound | Upper Bound | Minimum | Maximum |
| Subgroup I d = 1.2мм | 20 | 581.59 | 4.62 | 1.03 | 579.43 | 583.75 | 575.25 | 590.34 |
| Subgroup II d = 1.35мм | 20 | 581.40 | 0.74 | 0.16 | 581.06 | 581.75 | 580.08 | 582.25 |
| Subgroup III d = 1.5мм | 20 | 570.75 | 3.54 | 0.79 | 569.09 | 572.40 | 565.23 | 576.42 |
| Вкупно | 60 | 577.91 | 6.09 | 0.79 | 576.34 | 579.49 | 565.23 | 590.34 |

One Way ANOVA: F = 67.194; df = 2; p=0.0001**significant for p < 0.05.

### *Analysis of zirconium post systems with three diameters of Multilink Automix cement*

The analysis of the extraction force in Newton (N) zirconium post systems of Multilink Automix cement in the entire sample was 466.1 ± 11.8 N. The minimum or maximum value of the extraction force in Newtons was 451.1 vs 485.4 N. For 50% of the posts in the entire sample, the extraction force was less than 463.6 N. The table showing the analysis of the extraction strength in Newton's zirconium post systems of Multilink Automix cement is given in Table 2.

**Table 2: Force extraction of zirconium post systems of Multilink Automix cement by sub-groups of diameters**

| | | | | | 95% Confidence Interval for Mean | | | |
|---|---|---|---|---|---|---|---|---|
| Subgroup | N | Mean | Std. Deviation | Std. Error | Lower Bound | Upper Bound | Minimum | Maximum |
| subgroup I d = 1.2мм | 20 | 481.29 | 1.99 | 0.44 | 480.37 | 482.23 | 478.23 | 485.43 |
| subgroup II d = 1.35мм | 20 | 462.91 | 4.50 | 1.01 | 460.80 | 465.02 | 455.33 | 470.15 |
| subgroup III d = 1.5мм | 20 | 454.22 | 2.19 | 0.49 | 453.19 | 455.24 | 451.15 | 458.55 |
| Total | 60 | 466.14 | 11.79 | 1.52 | 463.09 | 469.19 | 451.15 | 485.43 |

One Way ANOVA: F = 394.366; df = 2; p =0.0001* *significant for p < 0.05.

The analysis of the extraction force in newtons (N) zirconium post systems of Multilink Automix cement according to subgroups of three diameters is consequently 481.3 ± 1.9 vs 462.9 ± 4.5 vs 454.2 ± 2.2.

In the Zirconium post Systems of Multilink Automix Cement in Subgroup I (d1 = 1.2 mm), the minimum, i.e. the maximum value of the extraction force is 478.2 vs 485.4 N, with 50% of the superstructure systems where the extraction force was lower from 481.2 N.

In the zirconium post systems of Multilink Automix cement in Subgroup III (d3 = 1.5 mm), the minimum, i.e. the maximum value of the extraction force is 451.1 vs 458.5 N, with 50% of the post systems in which the pulling power was lower from 453.7 N.

## Discussion

Zirconium post systems have higher resistance compared to other post systems. According to some authors, the failure rate of these post systems is only 3.2% during one to six years [11]. The authors concluded that these post systems could be used routinely only in combination with adhesive materials. It is very important to have a high potential for bonding dentine and complex resinous cement with zirconium post systems. Smooth cement showed success in some micro spaces [12] [13].

Significant average decrease in the extraction force by 18.39 (95% CI, 16.0-20.7) Newtons in measuring the Zirconium Upgrading Systems of Multilink Automix Cement in Subgroup II compared to Subgroup I (p = 0.0001).

For p < 0.05, there is a significant average decrease in the extraction force by 27.08 (95% CI, 24.7-29.4) Newtons to the Zirconium post Systems of Multilink Automix Cement in Subgroup III compared to Subgroup I (p = 0.0001).

The extraction force of Multilink Automix cement in Subgroup III compared to subgroup II for p < 0.05 is significantly lower for 8.69 (95% CI, 6.3-11.1) newtons (p = 0.0001).

Multilink Automix Cement, the extraction force of zirconium post systems is significantly reduced by increasing the diameter of post systems. A frequent recommendation among multiple authors is not to use a post with a diameter below 1.3 mm because weaker posts cannot provide sufficient stability [14]. 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 [15] [16].

The extraction force is significantly highest in Subgroup I with a significant reduction in the same for zirconium post systems from Subgroup II and Subgroup III. To determine the significance of the differences, the Tukey honest significant difference test (HSD) was applied. The differences in the values of the average extraction force of RelyX Unicem 2 Automix cement between the subgroups of zirconium post systems with three different diameters were analysed in the following combinations: Subgroup I / Subgroup II; Subgroup I / Subgroup III; and Subgroup II / Subgroup III).

In concordance to Tukey (HSD), the test for $p < 0.05$ points to a significant average reduction in pull-out force by 10.84 (95% CI, 8.2-13.4) novel when measuring the zirconium post systems of RelyX Unicem 2 Automix cement in Subgroup III compared to Subgroup I ($p = 0.0001$). The RelyX Unicem 2 Automix cement extraction force of subgroup III compared to Subgroup II is significantly lower by 10.66 (95% CI, 8.1-13.2) newtons ($p = 0.0001$). For $p > 0.05$, there is no significant reduction in the pull-out strength of zirconium post systems of RelyX Unicem 2 Automix cement between Subgroup I compared to Subgroup II, by 0.186 (95% CI, 2.4-2.8) novel ($p = 0.983$).

The extraction force of zirconium post cemented with RelyX Unicem 2 Automix cement in Newtons significantly decreases with the increase in the diameter of the post systems. The pullout force is significantly highest in Subgroup I, with its significance decreasing for Zirconium Upgrading Systems from Subgroup II and significant reduction of it for subgroup III zirconium post systems. The diameter of the post and the remaining dentin also play a major role in preventing fracture of the root. This corresponds with some In Vitro studies confirming the importance of the remaining tooth structure considering the strength and resistance of the root fracture [17] [18]. But according to some authors, when the diameter of the post increases, the surface of the tooth that is in contact with the tooth increases. According to some studies, increasing the diameter of the post does not significantly affect the retention capacities. However, it can increase the strength of the post and thus increase the risk of a root fracture [19] [20].

In conclusion, the largest diameter of the posts significantly increases the resistance of fractures compared to the smaller two diameters used in the experimental study. The extraction force of zirconium post systems that were cemented with both types of cement, the best results showed the post systems with diameter d3, compared with other diameters d1 and d2. From this, it can be concluded that the extraction force in zirconium post systems is significantly reduced by increasing the diameter of the post systems.

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