

## Effect of the diameter on Cu-Al post retention

### *Efeito do diâmetro na retenção de pinos de Cu-Al*

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**ABSTRACT:** This study compared the resistance to removal by traction of abraded cylindrical metal cast posts of Cu-Al (Goldent-LA). The posts had constant length (9 mm) and three different diameters (0.9, 1.3 and 1.7 mm), and were cemented with zinc phosphate cement. The crowns of 36 sound maxillary canines were sectioned, the roots were immersed in resin blocks and the root canals were endodontically treated. The teeth were divided into three groups to be prepared and standardized with the use of a parallelometer with the following burs: Group 1 - Largo n. 2; Group 2 - Largo n. 4; Group 3 - Largo n. 6. The posts were molded with chemically activated resin and after casting they were abraded and their dimensions were confirmed with a digital caliper. After cementation of the posts in the prepared root canals, the samples were kept at 37°C in distilled water for 7 days and subsequently submitted to the traction test in a universal testing machine (Instron 4444). The results showed no statistical difference between the groups. Diameter variation (0.9 mm, 1.3 mm and 1.7 mm) in abraded cylindrical posts cemented with zinc phosphate did not affect resistance to removal.

**DESCRIPTORS:** Tensile strength; Post and core technique.

**RESUMO:** Este estudo *in vitro* comparou a resistência à remoção por tração de núcleos metálicos fundidos em liga de Cu-Al (Goldent-LA) cilíndricos, jateados, de comprimento constante igual a 9 mm, cimentados com cimento de fosfato de zinco e com três diferentes diâmetros: 0,9 mm, 1,3 mm e 1,7 mm. Trinta e seis caninos superiores hígidos tiveram suas coroas seccionadas, sendo as raízes incluídas em blocos de resina acrílica, e os canais, tratados endodonticamente. Os dentes foram divididos em três grupos para serem preparados e padronizados com o auxílio de um paralelômetro com as seguintes brocas: Grupo 1 - Largo n° 2; Grupo 2 - Largo n° 4; Grupo 3 - Largo n° 6. Os núcleos foram moldados com resina acrílica ativada quimicamente e, após a fundição, foram jateados e tiveram as suas dimensões conferidas com um paquímetro digital. Após a cimentação, os corpos-de-prova foram armazenados em água destilada durante 7 dias, em estufa a 37°C e, posteriormente, submetidos a teste de tração em uma máquina universal de ensaios Instron 4444. Com a análise estatística dos resultados, pôde-se concluir que não houve diferença estatisticamente significativa entre os grupos testados. A variação do diâmetro em núcleos cilíndricos jateados cimentados com fosfato de zinco não afetou a resistência à remoção.

**DESCRIPTORIOS:** Resistência à tração; Técnica para retentor intra-radicular.

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## INTRODUCTION

Technical and scientific evolution in endodontics has led to the preservation of an increasing number of teeth. Studies have shown a high rate of success after endodontic treatments<sup>6,7,16</sup>; however, the type of restoration used for recovery of the shape, function and esthetics and protection of the dental remnant play an important role in the recovery of these teeth<sup>3,6</sup>.

The manipulation of the pulp cavity leads to greater fragility of endodontically treated teeth. The configuration of the roof of the pulp chamber, which is in the form of an arch, provides resistance to pressure and compression. With the removal of

this roof for endodontic access, this resistance is reduced and a restoration that provides internal resistance and external support for the remaining walls is needed.

The root canal filling does not provide resistance to this area; however, an intraradicular post should not be used for reinforcement. According to Sorensen, Martinoff<sup>19,20</sup> (1984) and Hansen et al.<sup>10</sup> (1990), the use of an intraradicular post to reinforce or increase tooth resistance is useless. The use of posts to improve resistance of the dental element does not have proven efficacy; studies have shown different results for this treatment<sup>4,15,16</sup>. Fracture

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resistance of endodontically treated teeth differs only slightly when compared to fracture of non-treated teeth; however, studies on teeth with posts report less resistance of teeth and show that the quantity of remaining root dentine is more important than the radicular contention for prevention of root fracture.

Researchers are concerned that the dental wear may be excessive during preparation of tooth diameter for metal cast posts. Thus, we evaluated the resistance to removal of abraded cylindrical Cu-Al metal cast posts cemented with zinc phosphate cement by traction, with different diameters.

## MATERIALS AND METHOD

Thirty-six maxillary human canines from the Dental Research Laboratory, University of Ribeirão Preto were used. These teeth were selected according to the shape and length of the roots (single canal and straight root, approximately 15 mm in length). These teeth also had a root diameter less than 0.9 mm at the cervical level because this was the smallest diameter of the posts tested.

Teeth were sectioned transversely at the cervical level next to the cemento-enamel junction with carborundum discs (Deutorium Ltda., New York, Brazil) and water spray cooling, and the crowns were discarded. The roots were embedded in acrylic resin (Artigo Odontológico Clássico, SP, Brazil) using a rectangular aluminum mold and kept in a hermetic sealed container with distilled water.

The root canals were instrumented to a working length of 14 mm (1 mm from the anatomical apex) with K-files (Dentsply Maillefer, Ballaigues, Switzerland) up to #40 (master apical file). Irrigation was performed with 1% sodium hypochlorite (Indústria Farmacêutica Rioquímica, São José do Rio Preto, Brazil) between files. Root canals were sealed with gutta-percha points (Dentsply, Petrópolis, Brazil) and Sealer-26® (Dentsply De Trey GmbH, Konstanz, Germany), using the lateral condensation technique. After obturation, the canals were sealed with Coltosol® (Vigodent, Rio de Janeiro, RJ, Brazil) and samples were kept in distilled water at 37°C for 7 days.

The samples were randomly divided into 3 groups (Figure 1) of 12 teeth and cylindrical post spaces with 9 mm in length were prepared with the following diameters: Group 1: 0.9 mm (prepared with #2 Largo bur - Dentsply Maillefer, Ballaigues, Switzerland); Group 2: 1.3 mm (prepared with a #4 Largo bur); Group 3: 1.7 mm (prepared with a #6

Largo bur). A new bur was used for each prepared tooth, totalizing 36 burs.

The root canals were prepared with a low-speed straight handpiece (Dabi Atlante, Ribeirão Preto, Brazil) attached to a parallelometer (Bio Art Ltda., São Carlos, Brazil), so that the root preparations were parallel to the long axis of the roots not allowing the introduction of horizontal forces when applying traction to the post-core system.

After the post space preparation, the root canals were molded using the chemically activated acrylic resin Duralay® (Reliance Dental Mfg. Co., Worth, IL, USA). These impressions were then included in silicon rings (Polidental, São Paulo, Brazil) (with one sample from each group in each ring) with Termocast® phosphate investment (Polidental Ind. Com. Ltda., São Paulo, SP, Brazil) and cast in copper-aluminum alloy (Goldent-LA, São Paulo, SP, Brazil), according to the manufacturer's instructions.

The root canals were cleaned with a detergent solution (tergensol, Inodon, Porto Alegre, RS, Brazil), dried with paper points (Dentsply, Petrópolis, Brazil) and air jet, and cemented with zinc phosphate (Vigodent, Rio de Janeiro, Brazil) by increments, according to the manufacturer's instructions.

The cement was placed in the canal with the help of a reamer and spread on the core with a spatula. The core was properly placed in the canal and small spinning movements were made to assist the cement flow. The core was kept in place with digital pressure for 5 minutes and the excess of cement was removed with a dental probe.

After cementation, the samples were kept at 37°C for 7 days.

All samples were subsequently placed in an Instron 4444 Universal Testing Machine (Instron Corporation, Canton, MA, USA), attached to a

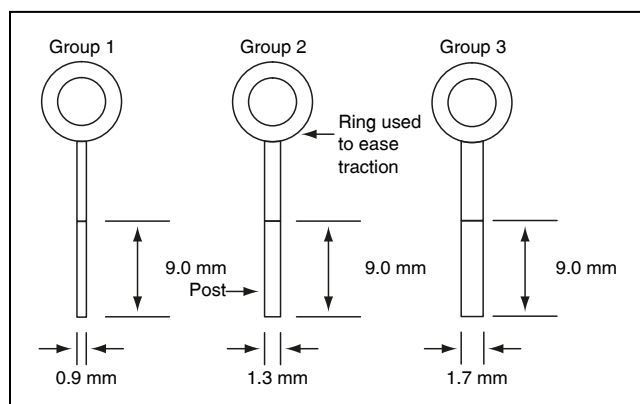


FIGURE 1 - Post configurations.

**TABLE 1** - Tension values to remove posts (kgf).

Specimens	Post diameter		
	Group 1 (0.9 mm)	Group 2 (1.3 mm)	Group 3 (1.7 mm)
1	16.80	28.56	21.97
2	10.88	30.22	29.16
3	18.83	10.12	23.17
4	13.76	14.69	17.03
5	26.08	21.25	24.28
6	20.13	25.95	23.58
7	16.23	19.24	34.22
8	15.41	26.40	14.47
9	24.29	16.57	26.81
10	16.86	31.26	25.47
11	28.20	29.07	20.31
12	33.81	21.96	38.68
Mean	20.10 ± 6.68	22.94 ± 6.76	24.92 ± 6.77

**TABLE 2** - ANOVA results for tensile strength.

	Sum of squares	DF	Mean square	(F)	Sig
Between groups	140.9727	2	70.4863	1.55	22.57%
Within groups	1499.336	33	45.4344		
Total	1640.309	35			

DF: degrees of freedom. Sig: significance level.

device developed to minimize lateral forces. The sample was maintained in vertical position in order to apply traction along the root axis. The posts were submitted to increasing traction (1 mm/min) until displacement from the root occurred. The maximum traction values, in kgf, were submitted to statistical analysis by ANOVA.

## RESULTS

Using the test of resistance to removal by traction of the posts, the means (± standard deviations) of the experimental data of the 36 numeric values of strength (kgf) were: Group 1: 20.10 ± 6.68; Group 2: 22.94 ± 6.76; Group 3: 24.92 ± 6.77 (Table 1).

Preliminary tests indicated normality and homoscedasticity. The ANOVA analysis was indicated and results can be seen in Table 2.

There were no statistically significant differences among the 3 groups (ANOVA,  $p > 0.05$ ).

## DISCUSSION

Currently, endodontic therapy has shown a high success rate (95%) and when correctly restored, the function of endodontically treated teeth does not differ from that of teeth with no treatment<sup>7,16</sup>.

The intraradicular post and core system, used for endodontically treated teeth restoration, is composed of 2 parts: the post, responsible for root retention and resistance<sup>4,11,15,19</sup>, and the crown extension, the core, responsible for crown retention. The post had a length of 9 mm, corresponding to 2/3 of the length of most human teeth<sup>15</sup> and considering that 4-5 mm of the root canal sealing should remain to protect the apical seal.

Despite scientific and technologic advances, the intraradicular post does not meet all the needs of a tooth with no pulp<sup>2</sup>. Resistance of an endodontically treated tooth is directly related to the quantity of remaining dental structure and is not reinforced by the post<sup>4,8,19</sup>. In fact, preparation for post insertion may lead to the weakening of the root<sup>9,18</sup>. These results are clinically important because the wear of the dental structure, during endodontic treatments, occurs during the endodontic access and the chemical-mechanical preparation, especially with cervical preparation techniques. The loss of tooth structure because of caries and trauma leads to a more fragile endodontically treated tooth<sup>6,17,22</sup>. Therefore, the clinician must abrade the least amount of dentinal structure possible

or only remove gutta-percha from the root canal, respecting the 4-5 mm apical limit and take advantage of the chemical-mechanical preparation already performed by the endodontist for placement of the intraradicular post; thus reducing the risk of fracture<sup>1,14</sup>.

The diameter of the core was evaluated because the preparation of larger posts than necessary can result in a weaker dental structure. According to some authors<sup>5,13,16,21,22</sup>, the diameter variation of posts to enhance resistance and retention leads to a higher risk of root perforation and fracture.

The chosen diameters (0.9 mm, 1.3 mm and 1.7 mm) were selected based on the mean diameter of human roots<sup>15</sup>. At 4 mm from the root apex, the maximum diameter of maxillary central incisors is 1.7 mm and 0.7 mm for mandibular central incisors. For the other groups of teeth, the diameter ranges between these values. The post diameter

must not allow deviation and must never exceed 1/3 of the root diameter<sup>12,15</sup>.

The results of the present study show that the tensile strength of Cu-Al cylindrical posts did not depend on the diameter and there were no significant statistical differences between the three compared groups. Table 2 indicates the probability of 22.57% to the equality hypothesis.

Clinically, regardless of the type of intracanal post used, root canal abrasion must be minimal, though sufficient for post placement, taking into account that post diameter does not affect retention and that the resistance of the dental element is directly related to the quantity of remaining dentin.

## CONCLUSIONS

The variation in diameter (0.9 mm, 1.3 mm and 1.7 mm) of cylindrical posts cemented with zinc phosphate did not affect their tensile strength.

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