

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL  
FACULDADE DE ODONTOLOGIA

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**INFLUÊNCIA DA TOPOGRAFIA DA COROA DENTÁRIA DE PRÉ-MOLARES  
SOBRE A RESISTÊNCIA A FRATURA EM DENTES COM PREPARO MOD E  
MANIPULADOS ENDODONTICAMENTE**

Porto Alegre

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Trabalho de Conclusão de Curso apresentado ao Curso de Graduação em Odontologia da Universidade Federal do Rio Grande do Sul, como requisito parcial para obtenção do título de Cirurgião-Dentista.

Orientador: Prof. Dr. Tiago André Fontoura de Melo

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2020

#### CIP - Catalogação na Publicação

de Mesquita, Carulina Bueno  
Influência da topografia da coroa dentária de  
pré-molares sobre a resistência a fratura em dentes  
com preparo MOD e manipulados endodonticamente /  
Carulina Bueno de Mesquita. -- 2020.  
34 f.  
Orientador: Tiago André Fontoura de Melo.

Trabalho de conclusão de curso (Graduação) --  
Universidade Federal do Rio Grande do Sul, Faculdade  
de Odontologia, Curso de Odontologia, Porto Alegre,  
BR-RS, 2020.

1. Dente tratado endodonticamente. 2. Pré-molar. 3.  
Resistência à fratura. 4. Técnica para retentor  
intrarradicular. 5. Topografia. I. Fontoura de Melo,  
Tiago André, orient. II. Título.

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Porto Alegre, 11 de novembro de 2020.

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## AGRADECIMENTOS

*Ao meu orientador e amigo, Prof. Dr. Tiago Melo, por dedicar seu tempo para o meu aprendizado, pela paciência e generosidade. Pela sensibilidade e acolhimento de sempre, que tornaram a construção desse trabalho prazerosa e pelo exemplo de professor e profissional.*

*A Prof. Dra. Fernanda Visioli, que foi a minha primeira orientadora de iniciação científica na graduação, por todo o tempo dedicado, pelos ensinamentos e generosidade. Foi através da nossa convivência e o teu exemplo que floresceu em mim a vontade de ser professora. Obrigada por tanta inspiração.*

*Aos meus pais, Tatiana e Enrique, pelo amor e apoio incondicionais, por sempre acreditarem em mim e estarem ao meu lado. A educação e valores que recebi permitiram que eu construísse meu caminho com empenho e confiança, sem vocês eu não teria chegado tão longe. A minha irmã Laura pelo amor e apoio.*

*A minha amiga e dupla, Giovanna, pela parceria e cumplicidade constante, vivemos intensamente nesses anos, nossa amizade foi um presente para a vida; as minhas amigas, Tatiane e Juliana Machado, pelo constante apoio e acolhimento, todos os cafés com vocês me fizeram seguir em frente com mais força. As minhas amigas Daiana, Fernanda e Juliana Moura, pelos muitos momentos que compartilhamos durante nossa vida acadêmica, todo o carinho de vocês deixou o meu caminho mais alegre e leve.*

*Ao meu companheiro, Stevan, que ao longo desses últimos oito anos esteve ao meu lado e tem sido meu grande amor e amigo. Pela companhia valiosa, pelo apoio desde os dias do vestibular, pelo amor e dedicação incansáveis comigo.*

*Aos amigos, colegas, professores e funcionários da Faculdade de Odontologia da Universidade Federal do Rio Grande do Sul pela convivência, ensinamentos e ajuda ao longo desses sete anos.*

## RESUMO

Objetivo: Avaliar se a topografia da coroa dentária influencia na resistência à fratura de pré-molares tratados endodonticamente e com preparo MOD submetidos a diferentes protocolos restauradores. Método: Sessenta e quatro pré-molares humanos com uma ou duas raízes em proporções numéricas (n) iguais, foram selecionados e divididos aleatoriamente em quatro grupos (n = 8), para cada uma das duas topografias analisadas (M = uma raiz; P = duas raízes): **MH**: hígido; **MNR**: endodontia (E) + preparo cavitário MOD; **MR**: E + MOD + restauração resina (RE); **MP**: E + MOD + RS + pino de zircônia horizontal (ZP); **PH**: hígido; **PNR**: E + MOD; **PR**: E + MOD + RS; **PP**: E + MOD + RS + ZP. Os preparos cavitários MOD foram padronizados com largura e profundidade dentro de cada uma das duas topografias. Após realização dos grupos, as amostras foram termocicladas e então submetidas ao ensaio de resistência à fratura. As falhas após o teste de fratura foram classificadas em: irrecuperáveis (assoalho pulpar) ou recuperáveis (sem fratura do assoalho pulpar). Para análise estatística foram utilizados teste T e ANOVA, seguido do teste de comparações múltiplas de Tukey, quando necessário. O nível de significância adotado foi de 5%. Resultados: Maior resistência à fratura foi observada nos pré-molares monorradiculares em relação aos polirradiculares ( $P < 0.05$ ). Na comparação entre os protocolos restauradores, independentemente da topografia dentária, não houve diferença estatística entre os dentes com ou sem restauração coronária sem pino transfixado. Diferença estatística foi obtida nos dentes com restauração direta associada a um pino transfixado ( $P < 0.05$ ), porém sem apresentar diferença em relação aos dentes hígidos. Conclusão: Pré-molares com uma raiz apresentam maior resistência à fratura do que com duas raízes. O tratamento restaurador com uso de pino de zircônia transfixado horizontalmente recuperou a resistência à fratura similar a um dente hígido.

**Palavras-chave:** Dente tratado endodonticamente; Pré-molar; Resistência à fratura; Técnica para retentor intrarradicular; Topografia.

## ABSTRACT

**Objective:** To evaluate whether dental crown topography influences the fracture resistance of premolars treated endodontically and with MOD preparation subjected to different restorative protocols. **Method:** Sixty-four human premolars with one or two roots in equal numerical proportions (n) were selected and randomly divided into four groups (n = 8): (M = one root; P = two roots) **MH:** healthy; **MNR:** endodontics (E) + MOD cavity preparation; **MR:** E + MOD + resin restoration (RE); **MP:** E + MOD + RS + horizontal zirconia post (ZP); **PH:** healthy; **PNR:** E + MOD; **PR:** E + MOD + RS; and **PP:** E + MOD + RS + ZP. MOD cavity preparations were standardized with width and depth within each of the two topographies. After allocation to the groups, the samples were thermocycled and then subjected to the fracture resistance test. Failures after the fracture test were classified as unrecoverable (with pulp floor fracture) or recoverable (without pulp floor fracture). For statistical analysis, T test and ANOVA were used, followed by Tukey's multiple comparison test, when necessary. The level of significance adopted was 5%. **Results:** Greater resistance to fracture was observed in single-root premolars compared to multi-root premolars ( $P < 0.05$ ). When comparing restorative protocols, regardless of dental topography, there was no statistical difference between teeth with or without coronary restoration without a transfixed post. Statistical difference was obtained in teeth with direct restoration associated with a transfixed post ( $P < 0.05$ ), but without any difference in relation to healthy teeth. **Conclusion:** Single-rooted premolars are more resistant to fracture than double-rooted premolars. The restorative treatment using a horizontally transfixed zirconia post improved fracture resistance, resembling that of a healthy tooth.

**Keywords:** Endodontically treated teeth; Premolar; Fracture Resistance; Post and core technique; Topography.



## LISTA DE ABREVIATURAS E SIGLAS

BP = buccal-palatal

CAAE = Certificado de Apresentação de Apreciação Ética

cm = centímetro

Dr. = doutor

Dr<sup>a</sup>. = doutora

E = endodontics

et al. = e outros

kN = quilograma força

M = one root

MD = mesiodistal

MH = grupo de monorradicular hígido

ml = mililitro

mm = milímetro

mm/min = milímetros por minuto

MNR = grupo de monorradicular não restaurado

MOD = méso-ocluso-distal

MP = grupo de monorradicular restaurado com pino transfixado

MR = grupo de monorradicular restaurado

n = número

N = newtons

P = two roots

PH = grupo de polirradicular hígido

PNR = grupo de polirradicular não restaurado

PP = grupo de polirradiular restaurado com pino transfixado

PR = grupo de polirradicular restaurado

Prof. = professor

Prof<sup>a</sup>. = professora

PVC = policloreto de vinila

RE = resin restoration

UFRGS = Universidade Federal do Rio Grande do Sul

ZP = horizontal zircônia post

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## 1. INTRODUÇÃO

A fratura dentária ainda é um problema frequentemente observado na rotina clínica do cirurgião-dentista. Elementos dentários, desprovidos de vascularização pulpar, tendem a apresentar uma maior fragilidade estrutural devido à desidratação dentinária com consequente perda de umidade e flexibilidade (DIKBAS *et al.*, 2007; SOARES *et al.*, 2007). Dentes hígidos raramente fraturam quando em função mastigatória normal (MONDELLI *et al.*, 2009).

Já se sabe que a taxa de sobrevivência do elemento dentário em relação à sua fratura está relacionada a inúmeros fatores, tais como a condição de oclusão dentária do paciente, a localização do dente na arcada, a quantidade de perda de tecido dentário, a existência de restaurações ou acesso endodôntico, ao estado periodontal e a conformação anatômica da coroa dentária (IQBAL *et al.*, 2003).

De acordo com a condição topográfica da coroa dentária (CAVEL *et al.*, 1985), o dente tende a apresentar uma maior ou menor suscetibilidade à fratura dentária, devido principalmente ao movimento de deflexão das cúspides quando submetido à carga mastigatória (ROCHA *et al.*, 2008).

Normalmente, quando ocorre a fratura dentária, ela está associada à fratura das cúspides. Fato esse que merece uma atenção especial, pois existe o risco de a linha de fratura estender-se abaixo da crista óssea, podendo acarretar a exodontia do dente ou dificultar a sua restauração (LAGOUVARDOS *et al.*, 1989).

Em dentes posteriores, especialmente para os pré-molares superiores, quando existe a confecção de um preparo cavitário tipo Classe II MOD (mésio-ocluso-distal) há um maior enfraquecimento dentário (COELHO DE SOUZA *et al.*, 2008). Em preparos MOD há a perda de estruturas importantes de reforço, tais como: ponte de esmalte e cristas marginais

(MONDELLI *et al.*, 1980; EAKLE, 1986). No entanto, quando o elemento dentário com preparo MOD é submetido ao tratamento endodôntico a tendência é de ainda haver uma maior fragilidade da peça dentária, pois ocorre a perda de uma outra estrutura de reforço, que é o teto da câmara pulpar. O teto da câmara pulpar, em um preparo MOD, passa a ser o “elo” de ligação mais próximo entre as cúspides, absorvendo e auxiliando na distribuição das tensões mastigatórias e funcionais sobre toda a superfície dentária (KHERA *et al.*, 1991; BURKE, 1992). Com todo esse enfraquecimento da estrutura dentária remanescente, ocorre o risco do alongamento das cúspides durante a oclusão dentária (JAGADISH; YOGESH, 1990), aumentando assim a probabilidade de deflexão destas e fratura do remanescente (GONZÁLEZ-LÓPEZ *et al.*, 2006; WU *et al.*, 2010).

Segundo Howe e McKendry (1990), dentes com preparos MOD e acesso endodôntico têm a resistência à fratura reduzida a 55% em relação a dentes que apresentam apenas o preparo cavitário tipo MOD. Frente a esta condição dentária descrita acima, a realização deste estudo buscou avaliar se o tipo de topografia coronária e se os protocolos restauradores influenciam na resistência à fratura.

## **2. OBJETIVOS**

### **2.1. Objetivo geral**

O objetivo deste estudo foi avaliar a influência da condição coronária, da característica radicular, do tratamento endodôntico e da modalidade restauradora na resistência à fratura de pré-molares.

### **2.2. Objetivos específicos**

- Avaliar se há influência de pré-molares com uma ou duas raízes sobre a resistência à fratura;
- Avaliar se a utilização do pino de zircônia transfixado à coroa dentária interfere na resistência à fratura;
- Avaliar e comparar os grupos experimentais quanto ao padrão de fratura das peças dentárias;
- e,
- Analisar, pelo método visual, o prognóstico do remanescente dentário após a ocorrência da fratura.

### 3. ARTIGO CIENTÍFICO

#### Dental crown topography and fracture of premolars with MOD preparation and restored with different protocols

##### Abstract

To evaluate whether dental crown topography influences the fracture resistance of premolars treated endodontically and with MOD preparation subjected to different restorative protocols. Sixty-four human premolars with one or two roots in equal numerical proportions (n) were selected and randomly divided into four groups (n = 8): (M = one root; P = two roots) MH: healthy; MNR: endodontics (E) + MOD cavity preparation; MR: E + MOD + resin restoration (RE); MP: E + MOD + RS + horizontal zirconia post (ZP); PH: healthy; PNR: E + MOD; PR: E + MOD + RS; and PP: E + MOD + RS + ZP. MOD cavity preparations were standardized with width and depth within each of the two topographies. After allocation to the groups, the samples were thermocycled and then subjected to the fracture resistance test. Failures after the fracture test were classified as unrecoverable (with pulp floor fracture) or recoverable (without pulp floor fracture). Means followed by the same lowercase or uppercase letter do not show statistical difference for Tukey's test ( $p > 0.05$ ): MH:  $1619.3 \text{ N} \pm 607.5^{\text{Aa}}$ ; MNR:  $524.9 \text{ N} \pm 330.3^{\text{Ba}}$ ; MR:  $803.3 \text{ N} \pm 190.3^{\text{Ba}}$ ; MP:  $1438.8 \text{ N} \pm 53.45^{\text{Aa}}$ ; PH:  $988.9 \text{ N} \pm 189.4^{\text{Ab}}$ ; PNR:  $373.4 \text{ N} \pm 103^{\text{Ba}}$ ; PR:  $507.7 \text{ N} \pm 152.7^{\text{Ba}}$ ; PP:  $1226.2 \text{ N} \pm 45.01^{\text{Cb}}$ . Teeth restored with a zirconia post showed 100% recoverable fractures. Single-rooted premolars are more resistant to fracture than double-rooted premolars. The restorative treatment using a horizontally transfixed zirconia post improved fracture resistance, resembling that of a healthy tooth.

**Keywords:** Endodontically Treated Teeth; Fracture Resistance; Premolar; Topography; Zirconia Post.

##### Acknowledgments

The authors deny any conflict of interest.

## Introduction

The fracture resistance of a tooth is directly related to the amount of remaining coronal tissue.<sup>1</sup> The loss of important structures, such as marginal ridges and pulp chamber roof, tends to increase cusp deflection under masticatory loads.<sup>2,3</sup>

Deflection of the cusp can result in the development and propagation of microcracks over time and, in extreme cases, cause fracture of the dental crown.<sup>4,5</sup> Therefore, the definitive restorative procedure is important to recover the anatomical features and function of the tooth and consequently reduce the mechanical fatigue on the cusps.<sup>6</sup>

According to Suliman *et al.*<sup>7</sup>, Tantbirojn *et al.*<sup>8</sup>, and Kim and Park<sup>9</sup>, the degree of cusp deflection is correlated to numerous factors, such as the restorative technique, the polymerization contraction power of the restorative material, and the shape and size of the cavity to be restored. For Cavel *et al.*<sup>10</sup>, the anatomical topography of the dental crown directly influences its fracture susceptibility. In the same year, Tjan and Whang<sup>11</sup> found that resistance to fracture of endodontically treated teeth is directly related to the remaining tooth structure, especially correlated with the distance between cusps (in the buccal-lingual direction). The identification of these factors can help modify operative treatment practices, preventing or reducing the chances of fractures.

Accordingly, the present study aims to evaluate whether the topography of the dental crown influences the fracture resistance of premolars with MOD preparation and subjected to different restorative protocols.

The initial hypothesis was that there would be no statistical difference in fracture resistance of endodontically treated single- or double-rooted premolars restored with composite resin associated or not with horizontally transfixed zirconia posts.

## Methods

This study was approved by the Research Committee of the Dental School of Universidade Federal do Rio Grande do Sul (UFRGS) and by the Research Ethics Committee of the same institution (CAAE process 85982618.0.0000.5347).

### *Sample selection and preparation*

Sixty-four single- or double-rooted human premolars in equal numerical proportions (n) were used in the study. The teeth should be free from caries, non-carious cervical lesions, restorations, or cracks. Double-rooted premolars should not have two fused roots.



The selected teeth had standardized buccal-palatal (BP) and mesiodistal (MD) crowns: single-rooted premolar (BP = 6.5 to 8 mm; MD = 6 to 7.5 mm) and double-rooted premolar (BP = 8 to 9.5 mm; MD = 8.5 to 10 mm). The measurement was performed with a digital caliper (Mitutoyo, Suzano, SP, Brazil) at the most prominent point on the respective faces.

After cleaning procedures, the teeth were disinfected and immersed in a plastic container with 0.5% chloramine solution (Seachem Laboratories, Madison, GA, USA) for 48 hours.

### *Experimental groups*

According to the type of premolar (single- or double-rooted), the teeth were randomly divided into experimental groups (Table 1) by simple random sampling using Excel®.

Table 1 - Layout of the experimental groups.

Groups	N	Type of premolar	Brief description of the groups
MH	08	single-rooted	Healthy tooth (positive control)
MNR	08	single-rooted	MOD prepared tooth + endodontics + without restoration (negative control)
MR	08	single-rooted	MOD prepared tooth + endodontics + restoration
MP	08	single-rooted	MOD prepared tooth + endodontics + transfixed post + restoration
PH	08	double-rooted	Healthy tooth (positive control)
PNR	08	double-rooted	MOD prepared tooth + endodontics + without restoration (negative control)
PR	08	double-rooted	MOD prepared tooth + endodontics + restoration
PP	08	double-rooted	MOD prepared tooth + endodontics + transfixed post + restoration

### *Preparation of specimens*

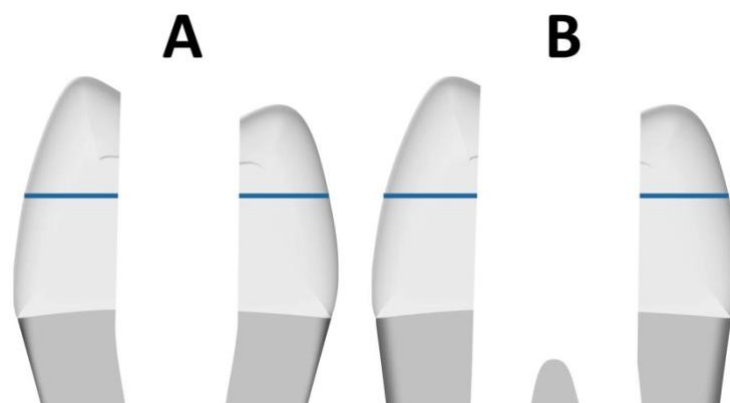
For individual inclusion of the teeth, PVC cylinders measuring 2 cm in height and 3 cm in diameter were used. The teeth were inserted in self-curing acrylic resin and centered inside the PVC cylinder, exposing the anatomical neck of the tooth 2 mm above the edge of the acrylic. The specimens were stored in distilled water.

### *MOD cavity preparation*

For MOD cavity preparations, equipment was used to standardize the inclination and movements performed by diamond tip #2143 (KG Sorensen, São Paulo, SP, Brazil) during the procedure.

Cavity preparations followed the methodology described by Cötert *et al.*<sup>12</sup>, and Beltrão *et al.*<sup>13</sup>. A line over the central groove was extended to the mesial surface, passing over the marginal ridge, going towards the dental neck until reaching a height of 4 mm. This was the depth established for the preparation. The predetermined buccopalatal width in the occlusal area was extended to the mesial surface, and equally established for the proximal boxes. Diamond tip #2143 was initially positioned on the mesial surface over the central line along the predetermined length. Next, a mesiodistal box with the same width as the tip was prepared. The buccal and palatal walls were prepared to the predetermined limits so that the gingival floor could be connected to the pulp floor of the occlusal box, forming a single mesiodistal corridor. Therefore, the MOD preparation should present only the buccal and palatal walls, a common mesiodistal floor, and the pulpobuccal and pulpopalatal angles, naturally rounded by the shape of bur #2143. The bur was replaced every five cavity preparations. The superficial cavity angle received manual finishing with margin cutters #28 and #29 (SSWhite Art. Dentários Ltda., Rio de Janeiro, RJ, Brazil). In single-rooted premolars, the width of MOD preparation was equivalent to that of diamond tip #2143. In double-rooted premolars, preparation size was one and a half times that of bur #2143. The thickness of the remaining walls, both buccal and palatal, was the same for all the teeth used in the experiment (Figure 1). MOD cavity preparation was not performed in teeth from the MS and PS groups. After MOD preparation, the specimens were stored in distilled water again.

Figure 1 - Schematic diagram of the MOD cavity preparation performed in single-rooted (A) and double-rooted (B) premolars.



### *Endodontic treatment*

Carbide burs #02 and #04 (KG Sorensen Ind. E Com Ltda., Barueri, SP, Brazil) were used to access the pulp chamber at high speed, under water cooling. Convenience form was obtained using the Endo Z tip (Dentsply Ind. E Com Ltda., Petrópolis, RJ, Brazil).

Initially, prior to chemomechanical preparation, cervical third preparation was performed with an La Axxess® bur (SybronEndo, Glendora, USA), #35, taper 0.6, at a depth of 5 mm site of access to the canal, under irrigation with 2.5% sodium hypochlorite (Iodontosul - Industrial Odontológica do Sul LTDA, Porto Alegre, RS, Brazil). The working length for preparing the canals was 1 mm below the outlet of the foramen. The chemomechanical preparation followed the serial technique using K-files #15, #20, #25, #30 and #35 (Dentsply/Maillefer, Ballaigues, Switzerland). Irrigation was carried out with a hypochlorite solution administered with a 10-mL plastic syringe and Navitip® needle with an external diameter of 0.30 mm (Ultradent Products, Inc South Jordan, Utah, USA).

After chemomechanical preparation, the canals were rinsed with 17% EDTA solution for 3 minutes with agitation of file #35 prior to filling. The canals were filled with gutta cones and epoxy resin-based cement - AH Plus® (Dentsply/Maillefer Instruments SA, Ballaigues, Switzerland) and by the Tagger hybrid technique using McSpadden® #60 compactor (Dentsply/Maillefer Instruments SA, Ballaigues, Switzerland).

### *Demarcation and perforation for post transfixation*

Zirconia posts with 1 mm in diameter were manufactured and customized for this study. Perforations for post transfixation were performed in the central portion of the coronal middle third of the buccal and palatal walls with a diamond bur #1090 (KG Sorensen, São Paulo, SP, Brazil), at high speed, under water cooling. Bur #1090 has a diameter equal to 1.2 mm, slightly larger than that of the post, which favored its better fit in the transfixation hole. The perforation of both sides, buccal and palatal, was made simultaneously on the same axis of insertion of the tip. The bur was changed every five cavity preparations.

### *Bonding of the zirconia post in a transfixed position*

First, the posts were silanized. To avoid any kind of contact with the post during silanization, the post was fixed to a useful wax sheet in a vertical position by one of its ends. The following procedures were performed according to the manufacturer's instructions:

- cleaning of the posts with 96% alcohol and drying with air jets.
- application of a silane layer (FGM Produtos Odontológicas, Joinville, SC, Brazil). Drying at room temperature followed by the application of air jets, at a distance of 15 cm, for one minute.
- application of a thin layer of Singlebond Universal adhesive (3M ESPE, St. Paul, MN, USA) and photoactivation with Bluephase G2 (Ivoclar) for 20 seconds.
- conditioning of enamel and dentin in the transfixation holes with 35% phosphoric acid (Dentispaly Ind e Com. Ltda, Petrópolis, RJ, Brazil) for 15 seconds, washing for 20 seconds, and drying with air jets.
- application of the Singlebond Universal adhesive in the transfixation holes, pulp chamber, and cavity preparation (half of its height), drying for 5 seconds, and photoactivation for 20 seconds.
- insertion of Bulkfill flow resin (3M ESPE, St. Paul, MN, USA) in the transfixation holes, insertion of the post in the transfixation holes, and photoactivation for 40 seconds.
- Bulkfill flow resin application in the pulp chamber and cavity preparation (half of its height), and photoactivation for 40 seconds.

#### *Restorative procedure*

The definitive restorative procedure was performed from middle part of the cavity preparation to the occlusal plane. All teeth, with or without transfixed posts, were filled from the pulp chamber to the middle portion of the preparation with Bulkfill flow resin, to a thickness of approximately 4 mm.

The occlusal portion was restored with composite resin Z350 (3M ESPE, St. Paul, MN, USA) with the following protocol:

- conditioning with 35% enamel phosphoric acid (30 seconds) and dentin (15 seconds), washing for 20 seconds, and drying with air jets.
- application of Singlebond Universal adhesive actively for 20 seconds, drying for 5 seconds, and photoactivation for 20 seconds.
- application of Z350 resin by the incremental technique (2 mm each) in the MOD cavity preparation and photoactivation for 40 seconds per increment.

After the restorative procedure, the specimens were placed back in distilled water and kept in an oven at 37°C for 48 hours.

### *Mechanical compression test*

After 48 hours, the specimens were initially thermocycled between 5°C and 55°C in 500 cycles. Then, the fracture resistance test was carried out on a universal testing machine EMIC DL - 2000 (São José dos Pinhais, PR, Brazil). A 10-kN load cell was selected and the speed was 0.5 mm/min.

A steel cylinder measuring 7.5 mm in diameter and 16 mm in length was applied to the inclined planes of the intercuspid surface of the occlusal surface of the specimen, in the mesiodistal direction, in contact with the cusps (buccal and palatal) rather than with the restorative material. Compressive stress was applied parallel to the long axis of the tooth until it fractured. The maximum fracture resistance (rupture) was recorded in Newtons.

Afterwards, the teeth were visually examined with a magnifying glass at 4X magnification to assess the dental fracture classified as: 1) irrecoverable (pulp floor fracture; 2) recoverable (cusp fracture without involvement of the pulp chamber floor). Irrecoverable fracture was considered when the tooth was split into two parts at the level of the pulp floor of the cavity, regardless of whether the direction was buccal/palatal or mesial/distal.

### *Statistical analysis*

The Shapiro-Wilk test was used to assess the normality of the data. ANOVA, followed by Tukey's multiple comparison test ( $\alpha = 5\%$ ) (SPSS 13.0, SPSS Inc., Chicago, Illinois, USA) and the T test was used to compare the groups.

## **Results**

Table 2 shows that teeth with a root restored with a post had the highest mean, differing statistically from the other groups of restored teeth.

Table 2 - Average of fracture resistance of teeth in Newtons (N) in the different experimental groups.

<b>Groups</b>	<b>Dental crown topography</b>	
	Single-rooted premolar	Double-rooted premolar
Control +	1619.3 ± 607.5 <sup>Aa</sup>	988.9 ± 189.4 <sup>Ab</sup>
Control -	524.9 ± 330.3 <sup>Ba</sup>	373.4 ± 103 <sup>Ba</sup>
Restored	803.3 ± 190.3 <sup>Ba</sup>	507.7 ± 152.7 <sup>Ba</sup>
Restored + Post	1438.8 ± 53.45 <sup>Aa</sup>	1226.2 ± 45.01 <sup>Cb</sup>

Means followed by different uppercase letters in the column and different lowercase letters in the row differ significantly according to ANOVA, followed by Tukey's test, in the column and the T test in the row at the 5% significance level.

Table 3 shows that the groups with horizontally transfixed zirconia posts (MP and PP) exhibited 100% recoverable fractures.

Table 3 - Site of dental fractures after mechanical testing in the different experimental groups.

<b>Groups</b>	<b>Fracture at the dental cusp level (recoverable)</b>	<b>Fracture at the pulp floor level (irrecoverable)</b>
MH	100% (8)	0% (0)
MNR	12.5% (1)	87.5% (7)
MR	25% (2)	75% (6)
MP	100% (8)	0% (0)
PH	100% (8)	0% (0)
PNR	0% (0)	100% (8)
PR	12.5% (1)	87.5% (7)
PP	100% (8)	0% (0)

## Discussion

The initial hypothesis of the present study was rejected, as there was a statistical difference between single-rooted and double-rooted premolars treated endodontically and restored with composite resin associated or not with zirconia posts in the horizontal position (Table 2).

Dental fracture has been reported as the third leading cause of loss of restored teeth.<sup>14</sup> Regarding resistance to dental fracture, *in vitro* mechanical fracture tests are performed to check the influence of restorative materials<sup>15</sup> and cavity preparations.<sup>16</sup>

The use of premolars was based on the studies by Wu *et al.*<sup>17</sup> and Bianchi *et al.*<sup>18</sup>, as this dental group presents an unfavorable anatomical configuration whose inclination of the cusps makes them more susceptible to fracture when subjected to occlusal loading, relative to the other posterior teeth.

MOD cavity preparation was performed on premolars for *in vitro* simulation of a clinical situation in which the cusps become more susceptible to deflection in the absence of marginal ridges. Schwartz and Robbins<sup>19</sup> found that the deflection of premolar cusps under occlusal load is greater in teeth treated endodontically and with MOD preparation. The pulp chamber roof, in an MOD preparation, becomes the closest "link" between the cusps, absorbing and assisting in the distribution of masticatory and functional tensions throughout the dental surface.<sup>20</sup>

According to the results obtained, healthy premolars had an average fracture load was 1,619.3 N for healthy single-rooted premolars and 988.9 N for double-rooted premolars, similar to the values found by other studies, which ranged from 792.5 N to 1,755.3 N.<sup>17,21,22,23</sup> This variability in values may be due to methodological differences, such as sample preparation, storage method, and the type of tooth and type of device used in the compressive loading applied in the fracture resistance test.

According to Coelho de Souza *et al.*<sup>24</sup>, the loss of dentinal structures weakens the dental crown and may compromise its resistance to fracture. This can be verified in teeth treated endodontically, with MOD preparation and without restoration (negative control), and in those restored only with composite resin, which also showed lower values of resistance.

Regarding the influence of dental topography, the distance between cusps in double-rooted teeth was greater than in single-rooted teeth and fracture resistance was lower. In the study by Larson *et al.*<sup>25</sup>, the authors found that prepared teeth were more susceptible to fracture than healthy teeth, and the factor that most influenced fracture resistance was the width of the occlusal portion of the preparation. That is, with the loss of marginal ridges, the remaining dental structures are weakened due to a greater width between the unsupported cusps, thus increasing the probability of their deflection and fracture of the remaining structure.<sup>17,26</sup> Thus, in a clinical approach, the morphological topography of the dental crown, associated with the degree of loss of dentinal structures, requires detailed planning regarding the type of rehabilitation and its prognosis.

A clinical treatment alternative described in the literature<sup>27</sup> that has shown good results regarding dentinal reinforcement, with total or partial recovery of dental resistance, is the transfixation of prefabricated posts during direct rehabilitation. In teeth whose restorative protocol was associated with transfixation of zirconia posts, a significant increase in fracture resistance can also be seen, which is in line with the studies by Karzoun *et al.*<sup>28</sup>, and Aslan *et al.*<sup>27</sup>, which also obtained excellent resistance results in teeth subjected to post transfixation.

In the studies by Karzoun *et al.*<sup>28</sup>, and Aslan *et al.*<sup>27</sup>, fiberglass posts were used because, according to the authors, this composition has a low modulus of elasticity similar to that of dentin, thus distributing loading forces evenly across the tooth.<sup>19</sup> In the present study, manufactured and customized zirconia posts were used and the results were surprising, since the average fracture load was statistically equal (single root) and higher (double roots) in teeth with transfixed posts in relation to healthy teeth. This can be explained by the high modulus of elasticity, rigidity, and hardness of this material.<sup>29</sup> In 2000, Rosentritt *et al.*<sup>30</sup> stated that the

physical and mechanical characteristics of zirconia posts can increase the structural strength of teeth.

The ideal modulus of elasticity for a post is controversial. Stiffer posts can improve the support of a coronal restoration and provide a more uniform distribution of stress, but, if overloaded, they can result in more catastrophic failure modes when compared to more flexible posts.<sup>31</sup> In the present study, this finding referring to zirconia posts cannot be considered in cases of transfixation, since 100% of the fractures of all the teeth subjected to this treatment were at the level of the dental cusp and not at the pulp floor level. Regardless of the modulus of elasticity, the transfixed post fulfills its role of promoting mainly the strengthening of the remaining dentinal structures. Mergulhão *et al.*<sup>32</sup> observed that the conventional composite resin restorative procedures performed showed a higher rate of irreparable fractures, and the insertion of a horizontally transfixed post in the dental crown decreased this prevalence.

## Conclusions

According to the results, it can be concluded that the topography of the dental crown correlates with the risk of fracture. The greater the distance between the cusps, the lower the resistance to fracture. The restorative treatment with the use of a transfixed zirconia post improved fracture resistance, which resembled that of a healthy tooth.

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#### **4. CONCLUSÃO**

O estudo conclui que a topografia da coroa dentária apresenta correlação ao risco de fratura. Quanto maior a distância entre as cúspides menor será a resistência para ocorrer a fratura. Além disso, o tratamento reabilitador direto com uso de pino de zircônia transfixado apresentou ser o melhor protocolo restaurador, recuperando a resistência à fratura em relação a um dente hígido.

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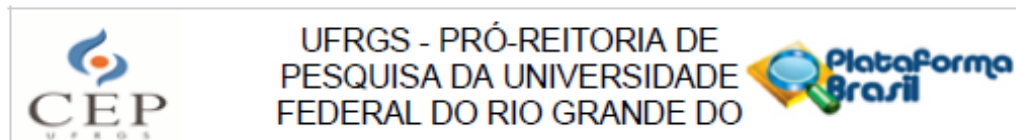
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## ANEXOS

## ANEXO A - Carta de aprovação do Comitê de Ética em Pesquisa



## PARECER CONSUBSTANCIADO DO CEP

## DADOS DO PROJETO DE PESQUISA

**Título da Pesquisa:** Influência da topografia da coroa dentária sobre a resistência à fratura em dentes com preparo MOD, manipulados endodonticamente, restaurados e transfixados por um pino de fibra de vidro.

**Pesquisador:** Tiago André Fontoura de Melo

**Área Temática:**

**Versão:** 3

**CAAE:** 85982618.0.0000.5347

**Instituição Proponente:** Faculdade de Odontologia

**Patrocinador Principal:** Financiamento Próprio

## DADOS DO PARECER

**Número do Parecer:** 2.672.538

**Apresentação do Projeto:**

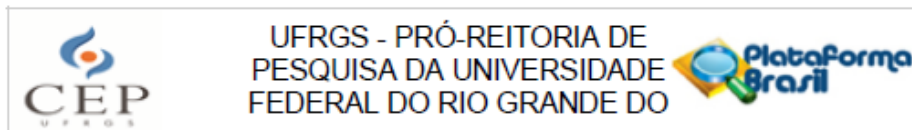
Trata-se de projeto de pesquisa a ser desenvolvido na Faculdade de Odontologia da Universidade Federal do Rio Grande do Sul. O mesmo envolve a participação de uma estudante de graduação, além de professores das áreas de Endodontia e Dentística da mesma Unidade Acadêmica. O projeto em tela prevê a avaliação da resistência à fratura de dentes pré-molares humanos extraídos e submetidos a preparo cavitário MOD, serão manipulados endodonticamente e em parte dos grupos experimentais teste será realizada a transfixação de um pino de fibra de vidro no interior do canal radicular. A amostra será composta de 80 dentes extraídos e divididos em 8 grupos experimentais composto por 10 dentes cada levando em consideração a topografia do elemento dentário. O projeto apresenta mérito acadêmico e científico à medida que pode contribuir com a geração de conhecimento na temática e auxiliar na busca por métodos alternativos para dar resistência adicional a dentes tratados endodonticamente e que apresentem a sua estrutura fragilizada.

**Objetivo da Pesquisa:**

**Objetivo Geral:**

- Avaliar se a topografia da coroa dentária de pré-molares, com preparo MOD, manipulado endodonticamente, restaurado e transfixado por um pino de fibra de vidro, influencia na sua

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**Telefone:** (51)3308-3738 **Fax:** (51)3308-4085 **E-mail:** etica@propesq.ufrgs.br



Continuação do Parecer: 2.672.538

resistência à fratura.

**Objetivos Específicos:**

- Avaliar se há influência da topografia da coroa dentária sobre a resistência à fratura;
- Avaliar se a utilização do pino de fibra de vidro transfixado à coroa dentária interfere na resistência à fratura;
- Avaliar e comparar os grupos experimentais quanto ao padrão de fratura das peças dentárias; e,
- Analisar, pelo método visual, o prognóstico do remanescente dentário após a ocorrência da fratura.

**Avaliação dos Riscos e Benefícios:**

Os riscos e benefícios são descritos conforme segue:

\*Análise crítica dos desconfortos e riscos previsíveis e benefícios esperados

-Não há desconfortos, benefícios diretos ou riscos previsíveis decorrentes da realização deste estudo ou da execução de seus métodos, visto que serão analisados dentes extraídos por motivos independentes do presente estudo.

Descrição das medidas de proteção ou minimização dos riscos previsíveis

-Os riscos associados à participação do estudo são mínimos. A quebra de sigilo ou de confidencialidade, associada à divulgação do nome do participante, será minimizada, uma vez que o TCLE e o Termo de doação de dentes ficarão sob a guarda do pesquisador responsável, e as informações relativas ao participante não serão divulgadas.

Descrição das medidas de monitoramento da coleta de dados e proteção à confidencialidade

-A coleta dos dentes será realizada um tempo após a sua extração, não havendo contato direto dos pesquisadores com o paciente. No entanto, dados, como, o nome completo e o Registro Geral serão solicitados no TCLE."

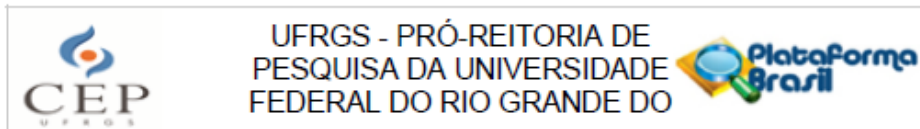
**Comentários e Considerações sobre a Pesquisa:**

O projeto trata-se de estudo in Vitro, encontra-se bem delineado e a metodologia claramente descrita e apropriada ao desenho experimental do estudo. Um cálculo de tamanho de amostra é apresentado com base em literatura relevante ao tema. Encontram-se anexados todos os documentos necessários e cartas de anuência de todos os setores envolvidos no projeto.

**Considerações sobre os Termos de apresentação obrigatória:**

Os autores apresentam os termos abaixo citados de forma apropriada:

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- Cartas de anuência dos setores de Cirurgia e Traumatologia Bucomaxilofacial e do Laboratório de Materiais Dentários devidamente assinadas;
- O Termo de Consentimento Livre e Esclarecido encontra-se presente e devidamente preenchido;
- Termo de doação de dente;
- Cronograma encontra-se com data de início para o dia 02/04/2018. Ressalte-se que o CEP não aprova sob nenhuma hipótese projetos em andamento sendo necessária alteração da data. (PENDÊNCIA)
- Orçamento está apropriadamente incluídos e descritos de modo que os custos do presente estudo estão sob responsabilidade do pesquisador principal;

RESPOSTA: O Cronograma foi devidamente alterado e encontra-se com data prevista de início para 25/06/2018

**Conclusões ou Pendências e Lista de Inadequações:**

Havia necessidade de adequação do cronograma. (PENDÊNCIA ATENDIDA)

Readequação da terminologia do TCLE para compreensão de público leigo (evitar termos como "condição anatômica", "relevância clínica", etc). O TCLE deve ser escrito sob a forma de convite e não sob a forma de declaração.

Ainda, sugeriu-se a remoção, na frase "-A coleta dos dentes será realizada um tempo após a sua extração, não havendo contato direto dos pesquisadores com o paciente. No entanto, dados, como, o nome completo e o Registro Geral serão solicitados no TCLE." de menção a coleta de dados pessoais (nome e RG, por exemplo) Esta coleta não somente é desnecessária, como não devem constar dados como RG no TCLE, o qual não é um documento de cunho legal.

RESPOSTA: O TCLE foi devidamente alterado e encontra-se com apropriada linguagem e de acordo com a Resolução 466/12.

A nova versão do projeto está em condições de aprovação.

**Considerações Finais a critério do CEP:**

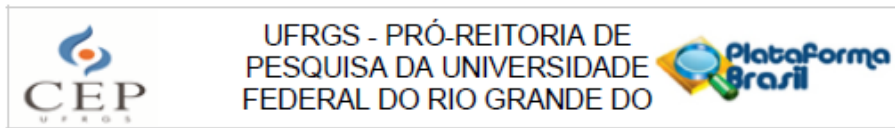
Aprovado.

**Este parecer foi elaborado baseado nos documentos abaixo relacionados:**

Tipo Documento	Arquivo	Postagem	Autor	Situação
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Endereço: Av. Paulo Gama, 110 - Sala 317 do Prédio Anexo 1 da Reitoria - Campus Centro  
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Continuação do Parecer: 2.672.538

Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1073037.pdf	17/05/2018 16:58:27		Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TERMO_DE_CONSENTIMENTO_LIVRE_E_ESCLARECIDO_PARA_PESQUISA.pdf	17/05/2018 16:56:02	Tiago André Fontoura de Melo	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_de_Pesquisa.pdf	17/05/2018 16:55:43	Tiago André Fontoura de Melo	Aceito
Folha de Rosto	FolhaDeRostoTiago.pdf	03/05/2018 13:18:28	Tiago André Fontoura de Melo	Aceito
Outros	Carta_de_Anuencia_da_Cirurgia.pdf	07/02/2018 10:23:21	Tiago André Fontoura de Melo	Aceito
Outros	Carta_de_Anuencia_do_LAMAD.pdf	07/02/2018 10:22:58	Tiago André Fontoura de Melo	Aceito
Outros	TERMO_DOACAO_DENTE.pdf	07/02/2018 10:22:16	Tiago André Fontoura de Melo	Aceito

**Situação do Parecer:**

Aprovado

**Necessita Apreciação da CONEP:**

Não

PORTO ALEGRE, 24 de Maio de 2018

Assinado por:  
**MARIA DA GRAÇA CORSO DA MOTTA**  
(Coordenador)

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**ANEXO B - Certificado da tradução do artigo para o idioma inglês**

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**CERTIFICATE**

This is to certify that Gilson André França de Mattos, technical translator with extensive expertise in the translation/revision of scientific articles, has been involved in the revision of the English language in the manuscript entitled "INFLUENCE OF DENTAL CROWN TOPOGRAPHY ON FRACTURE RESISTANCE OF PREMOLARS WITH MOD PREPARATION AND SUBJECTED TO DIFFERENT RESTORATIVE PROTOCOLS."

I do not take any responsibility for changes in the manuscript made by the authors and co-authors after my final revision without my knowledge and approval.



Gilson Mattos

Porto Alegre, March 19, 2020.