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ORIGINAL ARTICLE

Fracture resistance of post-core systems in teeth with missing dentin walls: an in-vitro study

Estudio in vitro de la resistencia a la fractura en sistemas poste-muñón en dientes con diferente número de paredes dentinarias

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ABSTRACT

Introduction: Endodontically treated teeth are structurally weakened and more prone to fracture due to loss of tooth structure, especially when one or more coronal walls are missing. Restoring such teeth with fiber post-and-core systems is a common strategy, but the influence of the number and location of remaining dentin walls on fracture resistance remains unclear.

Objective: To compare the fracture resistance of a fiber post-and-core system in endodontically treated teeth with varying numbers and locations of remaining dentin walls.

Material and Methods: In vitro laboratory experimental study conducted in a dental school research facility. Fifty extracted human premolars were selected and randomly assigned to five groups (n = 10). All teeth were endodontically treated and restored using a fiber post and composite resin core. The control group preserved all coronal walls, while groups A-D had one wall removed (palatal, buccal, mesial, or distal, respectively). Standardized tooth preparation and post cementation were performed. Data normality was assessed using the Shapiro-Wilk test. Group comparisons were performed using one-way ANOVA ($p < 0.05$).

Results: Mean fracture resistance values (±SD) by group were: 268.77 ± 119.00 N (A); 420.44 ± 132.65 N (B); 363.76 ± 102.57 N (C); 374.10 ± 158.62 N (D); 364.07 ± 147.28 N (Control). No statistically significant differences were found among groups ($p > 0.05$).

Conclusions: The presence or absence of a single dentin wall, regardless of its location, did not significantly affect the fracture resistance of endodontically treated teeth, restored with fiber post-and-core systems.

Keywords:
Post and core technique; dental stress analysis; in vitro; endodontically treated teeth; fracture resistance.

RESUMEN

Introducción: Los dientes tratados endodónticamente presentan un debilitamiento estructural y son más propensos a la fractura debido a la pérdida de estructura dentaria, especialmente cuando falta una o más paredes coronarias. La restauración de estos dientes mediante sistemas de poste y muñón de fibra es una estrategia común; sin embargo, la influencia del número y la localización de las paredes dentinarias remanentes sobre la resistencia a la fractura sigue siendo incierta.

Objetivo: Comparar la resistencia a la fractura de un sistema de poste y muñón de fibra en dientes tratados endodónticamente con diferentes números y localizaciones de paredes dentinarias remanentes.

Material y Métodos: Estudio experimental in vitro realizado en un laboratorio de investigación de una facultad de odontología. Se seleccionaron 50 premolares humanos extraídos y se asignaron aleatoriamente a 5 grupos (n = 10). Todos los dientes fueron tratados endodónticamente y restaurados con un poste de fibra y un muñón de resina compuesta. El grupo control conservó todas las paredes coronarias, mientras que a los grupos A-D les faltaba una pared (palatal, bucal, mesial, o distal, respectivamente). Se realizaron procedimientos estandarizados de preparación dentaria y cementación del poste. La normalidad de los datos se evaluó mediante la prueba de Shapiro-Wilk. Las comparaciones entre grupos se realizaron utilizando ANOVA de una vía ($p < 0,05$).

Resultados: Los valores medios de resistencia a la fractura (±DE) por grupo fueron: 268,77 ± 119,00 N (A); 420,44 ± 132,65 N (B); 363,76 ± 102,57 N (C); 374,10 ± 158,62 N (D); 364,07 ± 147,28 N (Control). No se encontraron diferencias estadísticamente significativas entre los grupos ($p > 0,05$).

Conclusiones: La presencia o ausencia de una sola pared dentinaria, independientemente de su localización, no afectó significativamente la resistencia a la fractura de los dientes tratados endodónticamente y restaurados con sistemas de poste y muñón de fibra.

Palabras Claves:
Técnica de poste y muñón; análisis de estrés dental; in vitro; dientes tratados endodónticamente; resistencia a la fractura.

INTRODUCTION

Endodontically treated teeth (ETT) are frequently restored in clinical practice after loss of pulp vitality due to caries, trauma, cracks, crown fractures, or extensive restorative procedures.[1] Although root canal treatment allows tooth preservation, the associated loss of coronal and radicular tooth structure may compromise biomechanical behavior and increase susceptibility to fracture.[2]

ETT are more susceptible to fractures than vital teeth due to various factors that weaken them and alter their biomechanical performance.[3] These changes can be attributed to alterations occurring at various levels, including tissue composition, the physical properties of dentin, the lack of vital pulp, and tooth architecture. The most significant loss of strength is associated with preparation for indirect restorations, particularly the removal of marginal ridges. Literature indicates a reduction in fracture resistance of 14-44% after occlusal preparation and 20-63% following mesio-occluso-distal (MOD) preparations.[4] Additionally, root canal instrumentation and the use of irrigating agents further compromise the mechanical resistance of dentin.[5]

Post-and-core systems are often employed to restore ETT when coronal tooth structure is insufficient. These systems not only improve retention of the final restoration but also help to restore function and esthetics. A variety of post materials are available, including metallic and non-metallic options such as fiberglass, carbon fiber, and zirconia.[6] Fiber posts are widely preferred due to their esthetic advantages and the ability to perform the procedure chairside, eliminating the need for laboratory involvement.[7] However, a key factor influencing the clinical success of fiber post restorations is the quantity and quality of the remaining dentin walls.[8] Fiber posts are indicated when the total coronal structure of the tooth is at least 3 walls, with a height of 2 mm (ferrule effect) and a minimum dentin thickness of 1 mm.[6] The ferrule effect refers to the encirclement of residual tooth structure by the crown margins, acting as a reinforcing band.[9] Studies have consistently shown that a taller and more uniform ferrule improves the biomechanical performance of restored ETT.[10] Bonding of adhesive materials to intraradicular dentin is further challenged by limited access, humidity control, and the configuration factor (C-factor).[11] The C-factor refers to the ratio of bonded to unbonded surfaces; a higher C-factor, such as in root canals, can result in greater polymerization stress and reduced bond integrity.[12]

Clinically, it is common to encounter teeth with partial or complete loss of coronal walls, limiting the ability to achieve a uniform ferrule. Despite the clinical relevance of this scenario, there is a lack of comprehensive literature analyzing how the location of missing dentin walls affects fracture resistance. Therefore, the **objective** of this in vitro study was to compare the fracture resistance of endodontically treated premolars restored with fiber post-and-core systems, under biological crown preparations with different combinations of missing dentin walls.

MATERIALS AND METHODS

This in vitro comparative study was conducted on 50 extracted human premolars obtained from the Clinic of the Faculty of Dentistry at the University of Chile, as well as from emergency services, private clinics, and/or dental offices. Teeth were consecutively collected according to predefined inclusion criteria, and all eligible specimens were included in the analysis; therefore, the study universe coincided with the final sample (n=50). No priori sample size calculation was performed. The sample size was determined by the number of eligible extracted premolars available during the collection period and by the balanced allocation of specimens across five experimental groups.

The study protocol was reviewed and approved by the Research and Ethics Committee of the Faculty of Dentistry, University of Chile. The study was attached to code: PRI-ODO 2014 PRI-ODO 14/009

All teeth were obtained following written informed consent from donors, who voluntarily agreed to donate their teeth for research purposes, in accordance with institutional ethical standards for the use of human biological materials.

The inclusion criteria were as follows:

- Premolars extracted for orthodontic or periodontal reasons, with sufficient coronal structure free of dentin-compromising caries.
- Recently extracted teeth, without previous endodontic treatment or fixed prostheses/restorations affecting dentin.
- Intact, unfractured roots with morphological homogeneity among specimens.

The selected teeth were cleaned from organic tissue residues, for example, remains of periodontal ligament and/or mineralized bacterial plaque, with an ultrasonic device (Cavitron; Dentsply Sirona, USA) and a periodontal curette (McCall SM 17/18; Hu-Friedy, USA). The tooth sample was preserved in 10% formalin to avoid dehydration and decomposition from the moment of extraction. Once cleaned, the sample was measured for root length in millimeters (mm) and tooth volume in milliliters (ml). The root length was measured from the cementoenamel junction (CEJ) to the tooth apex using a millimeter ruler. To establish the dentin volume of the prepared teeth, a graduated cylinder was used in tenths of milliliters, and the fluid displacement produced by the tooth when it was introduced. Teeth with a root length between 13 - 19 mm and a volume between 0.3 - 0.6 ml were selected. Of the total number of teeth collected, 50 were selected according to these criteria to be used in the study: 25 upper premolars and 25 lower premolars. (Table 1)

Table 1. Root length (mm) and volume (ml) of the selected tooth samples

Sample Nr	Root Lenght (mm)	Volume (ml)	Sample Nr	Root Lenght (mm)	Volume (ml)
1	17	0.4	26	17	0.5
2	18	0.4	27	13	0.6
3	13	0.4	28	16	0.5
4	16	0.4	29	13	0.4
5	16	0.4	30	13	0.4
6	14	0.4	31	14	0.5
7	15	0.4	32	15	0.5
8	17	0.4	33	15	0.4
9	13	0.3	34	14	0.4
10	14	0.5	35	15	0.4
11	19	0.4	36	16	0.4
12	15	0.4	37	13	0.3
13	16	0.4	38	14	0.4
14	13	0.4	39	16	0.4
15	19	0.4	40	15	0.4
16	19	0.5	41	16	0.3
17	14	0.4	42	12	0.3
18	15.5	0.3	43	15	0.3
19	14	0.4	44	14	0.4
20	14	0.3	45	19	0.4
21	17	0.4	46	17	0.3
22	13	0.3	47	19	0.4
23	15	0.5	48	18	0.5
24	15	0.4	49	17	0.4
25	13	0.4	50	19	0.4

Root canal preparation of all selected teeth was performed with K-files (Denstsply Maillefer, USA) using the corono-apicomedial technique of the University of Chile. Irrigation was performed using a 5% sodium hypochlorite (NaOCl) solution and saline solution to prevent any obstruction of the canals. The canals were obturated with a single guttapercha main cone, selected according to the master file, and accessory cones (DiaDent, USA), using either the lateral compaction technique or cold compaction, and Grossman cement (Hertz Lab., Chile). After obturation of the canals, adequate canal sealing in both length and width was confirmed by periapical radiographs. The 50 teeth were randomly assigned to five groups (n = 10 per group) using the Team Maker online tool (http://chir.ag/projects/team-maker/). The control group received full preparations with no wall removed. In groups A-D, one dentin wall was removed per group. The characteristics of the teeth included in each study group are presented in Figure 1.

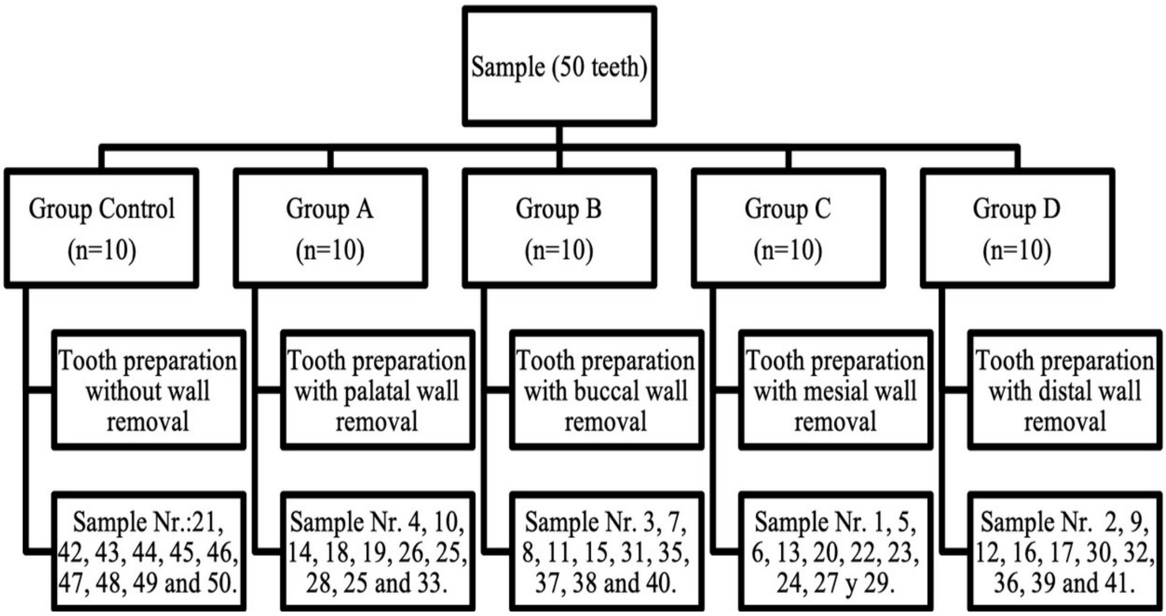

Figure 1. Randomization and tooth characteristics for each study group.

From the 50 ETT, ten were used as a control group. The occlusal surface of these teeth was reduced, maintaining their original anatomy, to a height of 3 mm, measured from the CEJ, and a peripheral preparation with a chamfer design was created, leaving 1 mm of dentin thickness. The reductions were verified with a North Carolina Periodontal probe (Hu-Friedy, USA). For the teeth of groups A, B, C, and D, the same reductions were performed, accompanied by the removal of the palatal (Group A), buccal (Group B), mesial (Group C), and distal (Group D) walls. Figure 2 shows a diagram of the wall removal corresponding to each study group. In each group, the gutta-percha was removed up to the required length with #1-3 peeso reamers (Dentsply Maillefer, Switzerland), leaving a 4-mm apical remnant. Post fit was verified before cementation by checking complete seating within the prepared post space and absence of visible interference. Before post cementation, the canals were dried with absorbent paper points, and the operative field was kept free of visible moisture during the cementation procedure. The cementation of the fiber posts was performed using a dual-polymerization resin auto-adhesive cement (BisCem, Bisco Inc., USA). Because a self-adhesive resin cement was used, no separate etching or adhesive conditioning protocol was performed beyond canal cleaning and drying. Once the core was reconstructed, increasing the height by 1 mm with composite (Filtek Z350 XT, 3M ESPE, USA), the excess remaining from the post was eliminated and polished with a polishing burr (SS WHITE Dental, USA), resulting in a 4 mm crown preparation. The process from tooth preparation to core build-up is shown in Figure 3.

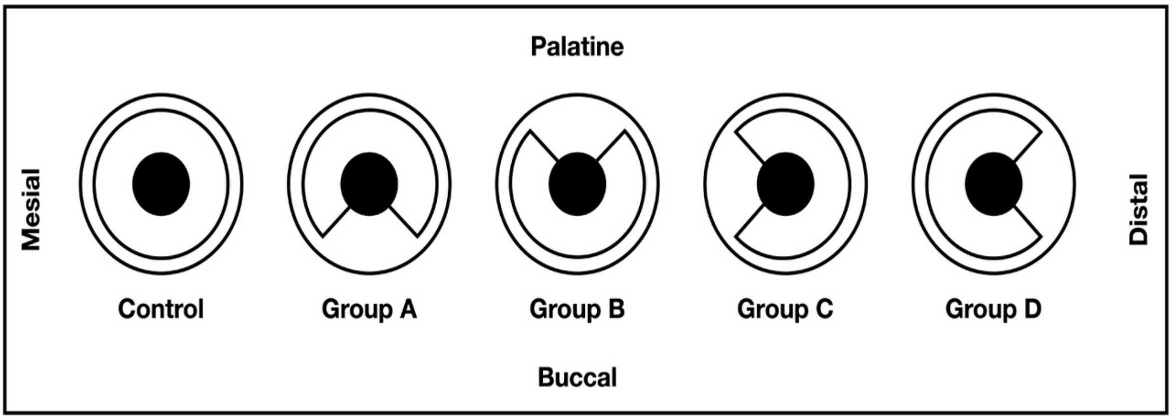

Figure 2: Diagram of the occlusal view of the tooth preparation and removal of a wall for each group

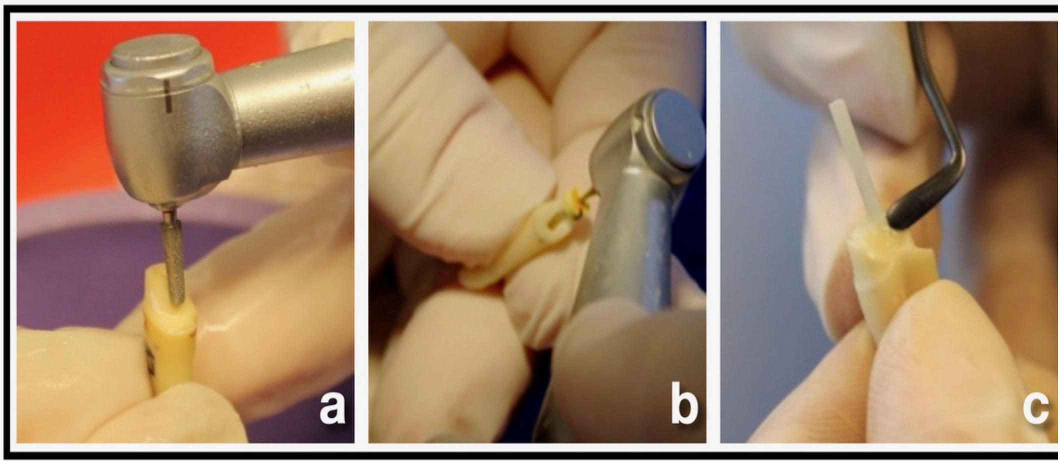

Figure 3: Tooth preparation, adhesive cementation of posts and abutment build-up; 3a: Tooth preparation; 3b: preparation of the prosthetic canal; 3c: cementation of the fiber post and construction of the resin core

An Instron model 3369 compression strength testing machine with a maximum load capacity of 50 kN was used for the fracture resistance test, provided by the Department of Materials Science at the Faculty of Physical and Mathematical Sciences, University of Chile. The specimens were introduced into wax cubes filled with self-curing acrylic, measuring 1 x 1 x 2 cm, with an inclination of 55°, to receive the test load, emulating the average inclination of oblique forces in posterior teeth. A compression load was applied on the vertex formed between the buccal and occlusal face of the tooth, with a speed of 5 mm per minute until tooth fracture occurred, as shown in Figure 4.

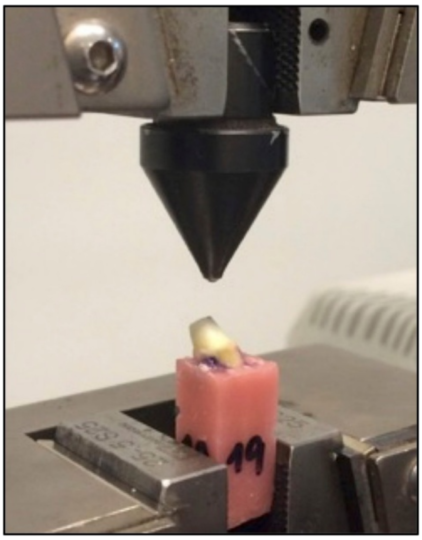

Figure 4: Instron machine applying compressive force on a tooth positioned in an acrylic cube

All statistical analyses were conducted with a statistical software (STATA 12.0; StataCorp, USA). Descriptive statistics, including means, standard deviations, and frequency distribution, were calculated for each group. Results from the four test groups were compared and analyzed using a one-way ANOVA test and a Shapiro-Wilk test to determine if the random sample had a normal distribution. Probability values of $P < 0.05$ were set as the reference for statistically significant results.

Primary research data are available in Zenodo's data repository for reuse and consultation, in accordance with the precepts of open science.[13]

RESULTS

Of a total of 50 fractures, 21 corresponded to root fractures (42%). The rest of the teeth presented only fractures to the core. Of the 21 root fractures, only one was horizontal, and the remaining 20 were oblique. Only 2 of the 21 root fractures occurred in the middle third of the root, and the rest happened in the cervical third. The mean fracture load value obtained for all groups (n = 50) was 358.22 ± 137.32 N, ranging from 104.35 to 723.41 N. The values of fracture loads (N), types, and locations of fractures that occurred for all groups are presented in Table 2.

Table 2. Values of fracture loads (N), type, and location of fractures in the teeth according to the number of missing walls

Sample Nr.	Absent Wall	Fracture load value (N)	Fractured wall	Root fracture
18	Palatal (A)	164.80	Proximal	Oblique, cervical third
4	Palatal (A)	302.01	Free Face	Oblique, cervical third
14	Palatal (A)	282.68	Proximal	Oblique, middle third
10	Palatal (A)	125.23	Proximal	Oblique, middle third
19	Palatal (A)	320.18	Proximal	Oblique, cervical third
33	Palatal (A)	192.33	Proximal	Oblique, cervical third
26	Palatal (A)	110.80	Proximal and Free Face	No
34	Palatal (A)	383.44	Free Face	No
25	Palatal (A)	480.72	Proximal	No
28	Palatal (A)	325.50	Free Face	No
Mean + SD	**Palatal (A)**	**268.77 ± 119.00**		
7	Buccal (B)	609.32	Proximal	No
3	Buccal (B)	423.22	Proximal	Oblique, cervical third
8	Buccal (B)	325.89	Proximal	No
15	Buccal (B)	429.57	Proximal	No
11	Buccal (B)	434.34	Proximal	No
31	Buccal (B)	128.29	Free Face	No
38	Buccal (B)	529.29	Proximal	Oblique, cervical third
35	Buccal (B)	420.98	Free Face	No
40	Buccal (B)	536.32	Free Face	Oblique, middle third
37	Buccal (B)	367.22	Proximal	Oblique, cervical third
Mean + SD	**Buccal (B)**	**420.44 ± 132.65**		
13	Mesial (C)	419.97	Proximal	No
6	Mesial (C)	347.82	Proximal	No
5	Mesial (C)	189.31	Proximal	No
1	Mesial (C)	182.45	Proximal	No
20	Mesial (C)	477.61	Proximal	Oblique, cervical third
24	Mesial (C)	383.00	Proximal	No
23	Mesial (C)	404.92	Proximal	No
22	Mesial (C)	469.68	Proximal	No
27	Mesial (C)	404.74	Proximal and Free Face	Oblique, cervical third
29	Mesial (C)	358.08	Proximal	No
Mean + SD	**Mesial (C)**	**363.76 ± 102.57**		
12	Distal (D)	104.35	Proximal and Free Face	Oblique, cervical third
16	Distal (D)	480.34	Proximal and Free Face	Oblique, middle third
2	Distal (D)	330.82	Free Face	No
9	Distal (D)	346.52	Proximal	Oblique, cervical third
17	Distal (D)	352.12	Proximal	No
32	Distal (D)	396.05	Proximal	No
41	Distal (D)	340.14	Free Face	No
39	Distal (D)	412.17	Proximal and Free Face	No
36	Distal (D)	723.41	Proximal and Free Face	Oblique, cervical third
30	Distal (D)	255.08	Proximal	No

Table 2 Cont. Table 2. Values of fracture loads (N), type, and location of fractures in the teeth according to the number of missing walls				
Sample Nr.	**Absent Wall**	**Fracture load value (N)**	**Fractured wall**	**Root fracture**
50	Distal (D)	202.27	Proximal	No
42	Control	653.48	Free Face	Oblique, cervical third
47	Control	494.25	Proximal	Horizontal, cervical third
45	Control	246.04	Proximal	Oblique, cervical third
21	Control	221.50	Free Face	Oblique, cervical third
46	Control	451.80	Proximal	Oblique, cervical third
43	Control	285.08	Free Face	No
49	Control	403.08	Proximal	No
44	Control	435.44	Proximal	No
48	Control	247.72	Proximal	Oblique, cervical third
Mean + SD	**Control**	**364.07 ± 147.28**		

Figure 5 shows a Box Plot where each group's minimum and maximum compression load values, average, and quartiles are represented. It is observed that the means of the groups with the absence of palatal wall (p) and absence of buccal or vestibular wall (v) are not symmetrical compared to the rest of the groups. It can also be seen that there are atypical force values in the control groups (none), the group with the absence of the palatal wall (p), and the group with the absence of the buccal wall (v).

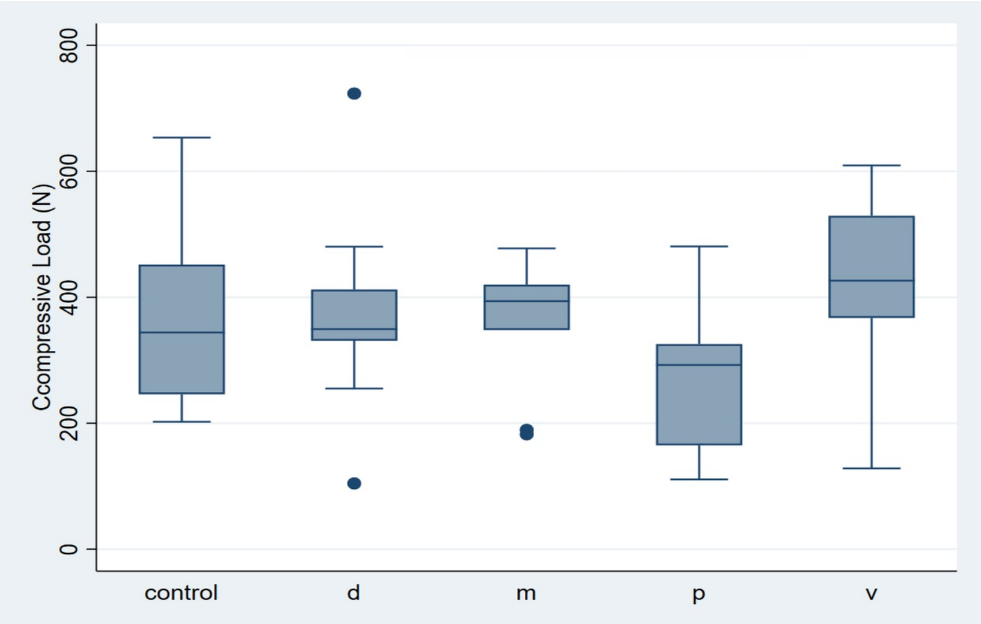

Figure 5. Box Plot. Minimum and maximum compressive load values for each group. Group A: palatal wall absent; Group B: buccal wall absent; Group C: mesial wall absent; Group D: distal wall absent; Control: no wall removed.

Once the above values were obtained, a Shapiro-Wilk test was performed on the fracture resistance measurements of each group to determine whether the random sample had a normal distribution, obtaining p-values of 0.252 for the control group and 0.677, 0.362, 0.057, and 0.277 for groups A, B, C, and D, respectively. Since the p-value in all groups was greater than 0.05, the results indicated a normal distribution. Subsequently, an analysis of variance (ANOVA) was performed to compare the results of all groups with each other. This analysis yielded a p-value of 0.164 ($p > 0.05$), indicating that there were no significant differences between the groups. Then, when the control group (which establishes the normality of values) was removed, the ANOVA showed a p-value of 0.0837 ($p > 0.05$), confirming that there were no significant differences in fracture resistance between groups A, B, C, and D. A post hoc power analysis was not performed; therefore, the absence of statistically significant differences should be interpreted cautiously, particularly considering the exploratory nature of this in vitro study and the limited number of specimens per group.

DISCUSSION

Preserving tooth structure is an essential factor in successfully restoring ETTs. Many authors have emphasized the importance of the presence, quantity, and quality of the coronal tooth remnant in determining the biomechanical behavior of the restored tooth, advocating a conservative approach during endodontic and restorative procedures.[9,10] In the present study, we investigated whether there were statistically significant differences in the fracture resistance of upper and lower premolar teeth restored with a fiber post-and-core system when comparing biological preparations with different dentin walls absent. The results showed no statistically significant differences in fracture resistance when comparing teeth with tooth preparations with absent palatal, vestibular, mesial, and distal walls. Therefore, there was insufficient evidence to reject the null hypothesis of equal mean fracture resistance among groups. This finding is consistent with a previous study[14] that evaluated the fracture resistance of ETT restored with preformed posts and with different missing walls in their preparations. In that study, it was concluded that having different designs in the biological preparations did not influence the fracture resistance of these teeth. However, it should be noted that biomechanical testing was performed with the previous placement of a fixed, full-metal peripheral prosthesis cemented with zinc phosphate, which more accurately simulates clinical conditions. In another in vitro study,[15] which compared the fracture resistance of ETT with 3 and 4 remnant walls and different locations of an absent wall, it was found that the location of the absent wall did not affect the resistance of ETT restored with a metal post system. In this study, as previously mentioned, complete peripheral fixed prostheses were also cemented over the biological preparations. On the other hand, a recent meta-analysis,[16] which included a sample of 807 teeth from in vitro studies, reported that a complete ferrule is superior to a partial ferrule in terms of fracture resistance, with no change in effect according to tooth type. In the present study, the fracture resistance of premolars varied between 104.35-723.41 N, with a mean of 358.22 N, a range that is comparable with a previous in vitro study, in which the fracture resistance of premolars varied between 172-782 N, with a mean of 458.8 N.[17] The aforementioned values are important since in patients with complete dentures, very varied occlusal force values have been reported[18] between 416.4 N ± 103.7 N and 611.2 N ± 202.9 N, depending on age and gender. Furthermore, in the posterior areas is where the maximum average occlusal forces are recorded, with ranges between 50 - 291 N in second premolars, 234 - 814 N in first molars, and 222 - 325 N in second molars.[19]

In a study evaluating the maximum bite force with hard and soft splints of different thicknesses in patients with bruxism,[20] a value of 626.65 ± 6.5 N was established for the control group. This is relevant since it is in parafunction where lateral forces can mostly be exerted on the premolar teeth, which, being consistent with the fracture values obtained, could eventually cause a fracture of the dental stump, regardless of the location of the missing dentin wall. The angle of load application used in this study mimicked the lateral forces applied to the premolars in parafunctional jaw movements, as lateral forces contribute more to tooth damage than axial forces.[15]

In this study, the sample was standardized according to tooth volume and root length, and teeth were randomly allocated to the study groups. Despite selecting anatomically similar teeth, complete uniformity could not be achieved. Root fractures accounted for 42% of failures, predominantly oblique fractures located in the cervical third, with only one horizontal fracture and two occurring in the middle third. This fracture pattern is consistent with previous studies[21] on ETT restored with preformed fiber posts, in which the fractures that might occur in these teeth tend to be repairable, i.e., fractures in the cervical third of the root or fractures of the core build-up. This is explained by the modulus of elasticity of these posts (similar to dentin) and also by the layer of cement that exists between the post and the dentin walls of the root canal, which can absorb strains when the tooth is under occlusal forces.

This study has limitations, including the small sample size and the static methodology used for fracture resistance testing. Moreover, the findings are mainly applicable to posterior teeth. In addition, blinding of the fracture evaluator was not documented, which should be considered when interpreting the descriptive classification of fracture patterns. Future studies should include larger samples, dynamic loading protocols, and restorations with complete fixed prostheses to better simulate clinical conditions, generate a ferrule effect, and assess its influence in teeth with varying degrees of dentin wall loss.

CONCLUSIONS

Within the limitations of this study, it was concluded that there are no statistically significant differences in the fracture resistance of endodontically treated premolars with biological preparations for fixed prostheses with different locations of an absent dentin wall, and the most prevalent fractures in the teeth studied are core fractures or oblique fractures in the cervical third of the root. These findings suggest that, under the present experimental conditions, the location of a single missing dentin wall may not by itself determine the selection of a fiber post-and-core system in endodontically treated premolars.

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REFERENCES

1. Kong X, Vishwanath V, Neelakantan P, Ye Z. Harnessing antimicrobial peptides in endodontics. International Endodontic Journal [Internet].2024;57(7):815-40. Aviable from: https://doi.org/10.1111/iej.14043
2. Manfredi M, Figini L, Gagliani M, Lodi G. Single versus multiple visits for endodontic treatment of permanent teeth. Cochrane Database of Systematic Reviews [Internet]. 2016;12. Aviable from: https://doi.org/10.1002/14651858.CD005296.pub3
3. Liao W-C, Chen C-H, Pan Y-H, Chang M-C, Jeng J-H. Vertical Root Fracture in Non-Endodontically and Endodontically Treated Teeth: Current Understanding and Future Challenge. Journal of Personalized Medicine. 2021;11(12):1375.
4. Dietschi D, Duo O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: A systematic review of the literature--Part 1. Composition and micro-and macrostructure alterations. Quintessence international. 2007;38(9):733-43.
5. Haupt F, Wiegand A, Kanzow P. Risk Factors for and Clinical Presentations Indicative of Vertical Root Fracture in Endodontically Treated Teeth: A Systematic Review and Meta-analysis. Journal of Endodontics [Internet]. 2023;49(8):940-52. Aviable from: https://doi.org/10.1016/j.joen.2023.06.004
6. Martins MD, Junqueira RB, de Carvalho RF, Lacerda MFLS, Faé DS, Lemos CAA. Is a fiber post better than a metal post for the restoration of endodontically treated teeth? A systematic review and meta-analysis. Journal of Dentistry [Internet]. 2021;112:103750. Aviable from: https://doi.org/10.1016/j.jdent.2021.103750
7. Batista VEdS, Bitencourt SB, Bastos NA, Pellizzer EP, Goiato MC, dos Santos DM. Influence of the ferrule effect on the failure of fiber-reinforced composite post-and-core restorations: A systematic review and meta-analysis. The Journal of Prosthetic Dentistry [Internet]. 2020;123(2):239–45. Aviable from: https://doi.org/10.1016/j.prosdent.2019.01.004
8. AlSaleh E, Dutta A, Dummer PMH, Farnell DJJ, Vianna ME. Influence of remaining axial walls on of root filled teeth restored with a single crown and adhesively bonded fibre post: A systematic review and meta-analysis. Journal of Dentistry [Internet]. 2021;114:103813. Aviable from: https://doi.org/10.1016/j.jdent.2021.103813
9. Meng Q, Chen Y, Ni K, Li Y, Li X, Meng J, et al. The effect of different ferrule heights and crown-to-root ratios on fracture resistance of endodontically-treated mandibular premolars restored with fiber post or cast metal post system: an in vitro study. BMC Oral Health [Internet]. 2023;23(1):360. Aviable from: https://doi.org/10.1186/s12903-023-03053-4
10. Al-Dabbagh RA, Sindi MA, Sanari MA, Manna AI, Al-Dabbagh MA. Effect of a circumferential ferrule on the survival and success of endodontically treated teeth restored with fiber posts: A systematic review and meta-analysis. The Journal of Prosthetic Dentistry [Internet]. 2024;132(6):1251-9. Aviable from: https://doi.org/10.1016/j.prosdent.2023.12.002
11. Özcan M, Volpato CAM. Current perspectives on dental adhesion: (3) Adhesion to intraradicular dentin: Concepts and applications. Japanese Dental Science Review [Internet]. 2020;56(1):216-23.Aviable from: https://doi.org/10.1016/j.jdsr.2020.08.002
12. Zhou Z, Guo D, Watts DC, Fischer NG, Fu J. Application and limitations of configuration factor (C-factor) in stress analysis of dental restorations. Dental Materials [Internet]. 2023;39(12):1137-49. Aviable from: https://doi.org/10.1016/j.dental.2023.10.014
13. Toro M. Dataset- In-vitro Comparison of Fracture Resistance in Post-Core Systems Among Teeth with Different Numbers of Dentin Walls [Internet]. Bruselas: Zenodo; 2026. Aviable from: https://doi.org/10.5281/zenodo.19484973.
14. Ozel E, Dikbas I, Tanalp J, Koksal T, Ersoy M. Evaluation of the effect of different ferrule designs on the fracture resistance of endodontically treated maxillary central incisors incorporating fiber posts, composite cores and crown restorations. The journal of contemporary dental practice [Internet]. 2009;8(7):62-9. Aviable from: https://doi.org/10.5005/jcdp-8-7-62
15. Arunpraditkul S, Saengsanon S, Pakviwat W. Fracture Resistance of Endodontically Treated Teeth: Three Walls versus Four Walls of Remaining Coronal Tooth Structure. Journal of Prosthodontics [Internet]. 2009;18(1):49-53. Aviable from: https://doi.org/10.1111/j.1532-849X.2008.00375.x
16. Al-Sanabani FA, Al-Makramani BM, Alaajam WH, Al-Ak-hali MS, Alhajj MN, Nassani MZ, et al. Effect of partial ferrule on fracture resistance of endodontically treated teeth: A meta-analysis of <i>in-vitro</i> studies. Journal of Prosthodontic Research [Internet]. 2023;67(3):348-59. Aviable from: https://doi.org/10.2186/jpr.JPR_D_22_00170
17. Ng CCH, Dumbrigue HB, Al-Bayat MI, Griggs JA, Wakefield CW. Influence of remaining coronal tooth structure location on the fracture resistance of restored endodontically treated anterior teeth. The Journal of Prosthetic Dentistry [Internet]. 2006;95(4):290-6. Aviable from: https://doi.org/10.1016/j.prosdent.2006.02.026
18. Shiga H, Komino M, Yokoyama M, Sano M, Arakawa I, Nakajima K, et al. Relationship between age and occlusal force in adults with natural dentition. Odontology [Internet]. 2023;111(2):487-92. Aviable from: https://doi.org/10.1007/s10266-022-00750-4
19. Atlas AM, Behrooz E, Barzilay I. Can bite-force measurement play a role in dental treatment planning, clinical trials, and survival outcomes? A literature review and clinical recommendations. Quintessence Int [Internet]. 2022;53(7):632-42. Aviable from: https://doi.org/10.3290/j.qi.b3044939

20. Benli M, Özcan M. Short-term ĥ of material type and thickness of occlusal splints on maximum bite force and sleep quality in patients with sleep bruxism: a randomized controlled clinical trial. Clinical Oral Investigations [Internet]. 2023;27(8):4313-22. Aviable from: https://doi.org/10.1007/s00784-023-05049-4

21. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies). Quintessence international. 2008;39(2):117-29

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity.

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