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EFFECT OF DIFFERENT POST AND CORE ON COMPOSITE RESIN CROWNS. AN VITRO STUDY

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ABSTRACT

The purpose that we did this study was to assess the adaptation of the margin, modes of fracture, and failure loads of composite crowns featuring different substructure on premolar teeth that had undergone root canal treatment. The study involved 48 lower teeth with only one root canals, which divided into equal six groups: a control group which received no treatment, a group that restored endodntically and had access cavity restored with composite resin, and four groups that underwent root canal treatment, had a ferrule (2mm), and received a standardized composite resin crown (SRCC) with different post materials (glass fiber, zirconium, or cast gold). Marginal adaptation was assessed by scanning the tooth-cementing composite (IF1) and cementing-composite-crown (IF2) interfaces using an electron microscope after all teeth were subjected to a thermocycling and mechanical load test in a computer-controlled and regulated masticator. The findings showed that following exposure to thermocycling and mechanical stress at IF1, marginal adaption declined markedly in groups III and IV, and in group V, at IF2. Half of the specimens showed signs of root fracture regardless of the substructure employed, and there was no statistically significant difference in the main loads to failure between the groups that received SRCCs. All of the examined posts had a good beneficial influence on adaptation of the margin at IF1, but none of them affected the failure modes or loads that caused failure of resin composite crowns.

KEYWORD: ىomposite crown ,marginal fit ,marginal fracture, mode of fracture, and post and core

INTRODUCTION

Dental practitioner must restore a tooth after root canal treatment to restore oral functions while protecting the remaining bone and muscle and preventing microleakage of bacteria and hard-tissue fracture. Research study show that preserving dental hard tissue during treatment reduces the risk of fractures. However, endodontic therapy is often necessary after big hard-tissue loss from decay or tooth reduction. In such cases, there may not be enough dental hard tissue left for proper restoration retention.

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Previously, dental post and cores were used in all teeth after endodontic treatment, but later studies found that a ferrule of at least 1.5 mm is more important than post length for tooth survival. Different materials with different modulus of elasticity have been used for dental post and cores, including cast gold alloys, stainless steel, titanium, and zirconium, as well as glass, , quartz, or carbon-reinforced composites. These fiber-reinforced posts are preferred by some dentists due to lower costs, no need for a dental technician, and fewer appointments.

Since stiff posts may supply superior support for the coronal restoration but may also contribute to severe failure modes such deep vertical root fractures, the optimal modulus of elasticity of a dental post is debatable. However, posts with more flexibility may bow under heavy loads, resulting in restoration failure, but may still leave the root intact, allowing for endodontic retreatment. There is a significant danger of subsequent decay or root canal infection due to coronal leakage if the restoration moves due to the use of an elastic post.

Another technique involves using of (endo-crowns) replacement of the original posts and cores, reducing the amount of healthy dentin that must be resected and eliminating the risk of root perforation. (CAD/CAM-)created all-ceramic -endo-crowns in molars and premolars had high survival rates in a clinical investigation. Studies conducted in vitro have shown that the absence of posts has either no influence on the teeth's fracture resistance or a beneficial effect on it.

The current research examined extensively damaged premolars with different post-and-core systems or endo-crowns to measure the resistance to fracture of natural premolars prior to and following endodontic treatment. We hypothesized that composite resin endo-crowns with the same modulus of elasticity as dentin and glass fiber post reinforced composite crowns would have fewer major failures compared to all ceramic post and core systems with an elevated modulus of elasticity, and we found that these predictions were mostly supported by the data. Marginal adaptation was measured between the cementing composite and the crown and between the luting composite and the tooth tissue.

MATERIALS AND METHODS

The researchers selected 48 single root teeth from lower premolars and canines for the study, using visual inspection, digital caliper measurement, and radiographs to ensure they met the criteria. They excluded teeth with curvy roots and atypical root canals. Sixteen teeth were selected free of decay mandibular premolars used as controls, while the remaining 32 teeth were habhazardly divided into four experimental groups. All the teeth were stored in thymol solution until treatment.

Root canal treatment was performed on all teeth except those in one group. The canals were prepared using various instruments, rinsed with sodium hypochlorite, and restored with gutta percha and sealer. Temporary restoration was placed over the access cavity, and the teeth were kept in regular drinking water.

The non endo treatment group did not have their teeth prepared, while the other groups had the temporary restorative removed and the endodontic filling removed upto the cementoenamel junction. Access cavities were then filled with a fine nanohybrid composite and the restoration surface was finished and then polished. Clinical crowns of the teeth in the groups III to VI were removed, leaving roots 13G1 mm long, and a circular preparation was made with diamond burs.

Crown fabrication

A study conducted tooth preparations in different groups using different types of posts or no posts. In group III,there is no posts were inserted and the preparation finished with diamond burs resulting in a circular preparation. In group IV, glass fiber posts were inserted, and adhesive cement was

applied before filling the canal with resin luting material. A hybrid composite core was built up and polymerized, and finished using tapered diamond burs. In group V, zirconia oxide posts were used, and the cores were fabricated in a dental laboratory using wax and glass ceramic material. The posts were inserted using resin luting material and dentin bonding, and finished with tapered diamond burs. In group VI, precious alloy posts were used, and the cores were fabricated in a dental laboratory using wax and a gold alloy. The posts were inserted using glass-ionomer cement, and finished using tapered diamond burs. A standardized preparation was achieved with a 2mm high ferrule and 0.8mm width in all groups. The teeth were imaged and digital imprints were utilized to create the crowns, allowing for uniform, well-fitted crowns on all teeth despite minor variances.

Crown placement

The process of placing crowns involved cleaning all teeth with water, toothpaste, and rotating nylon brushes. The teeth were then carefully prepared and refinished using finishing diamond burs with water cooling. Syntac Primer and Adhesive were applied and little dried before Helio bond was carefully applied and thinning it with air. The crowns were conditioned with silane before they were filled using restorative composite (Tetric) and molded to fit all of the crown's internal surfaces. Ultrasound was then used to bond the crowns to the suitably prepared teeth, and any extra composite was scraped away. All tooth roots were coated with polyvinylsiloxane polymer and placed in autocured resin on SEM specimen carriers. Before and after a thermomechanical stress, the changes in marginal adaptation were studied using SEM. All specimens were thermally strained with 3000 temperature cycles and mechanically loaded at the middle of the occlusal surface in the computer-controlled masticator. Coronal leakage was detected by immersing the specimens in fuchsin solution and loading them in a universal test machine.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Oblique at CEJ		5	5	4	3	5
Oblique below CEJ	2			1	2	
Crown dislodgement	2					

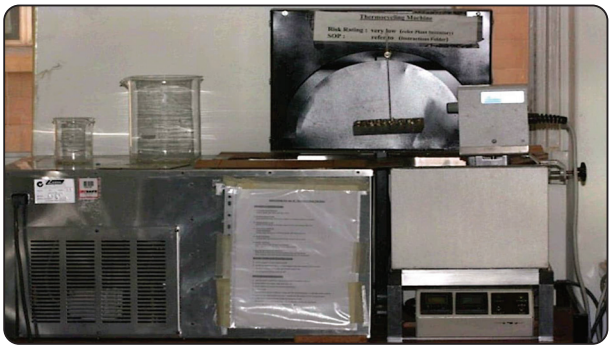
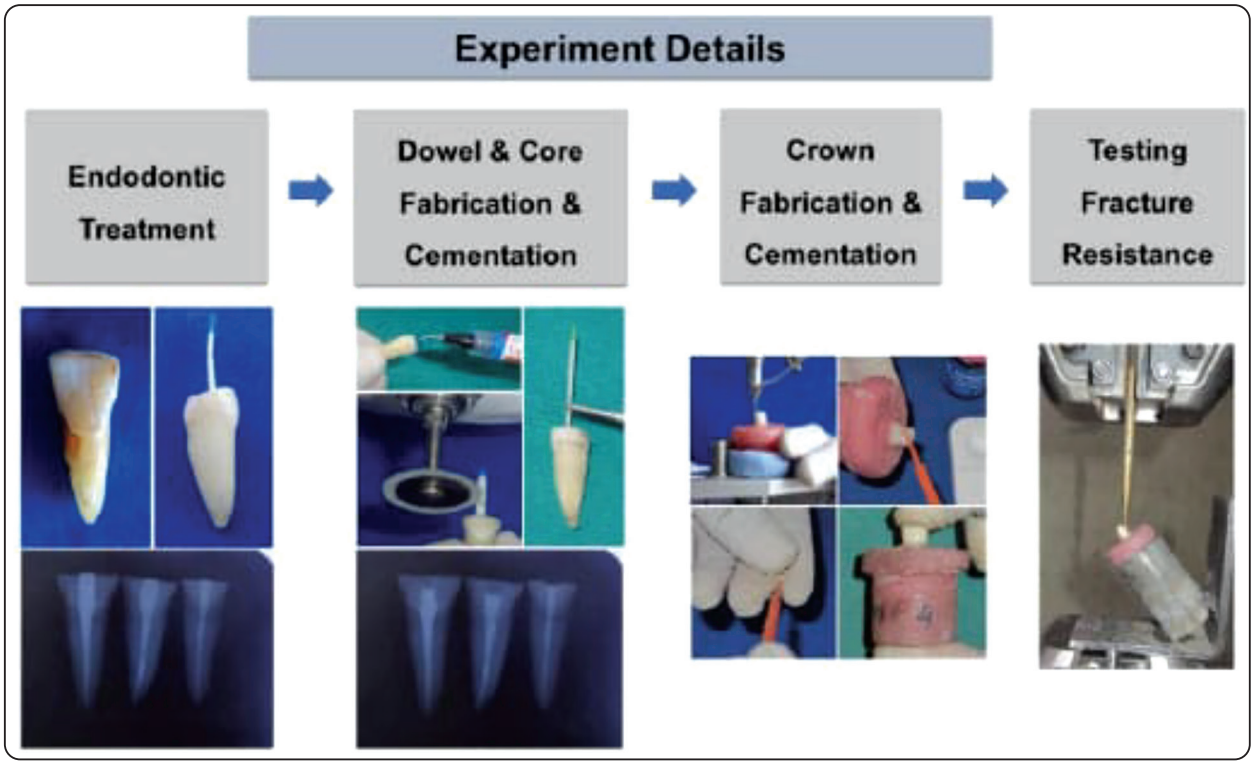


Fig. (1) Thermocycling machine

During testing, a thin layer of tin foil (0.5mm) was inserted between the steel sphere and the crown to help disperse the force and prevent excessive pressure from being applied to the resin composite crown surfaces. The force was evaluated in newtons, and averages were then determined for each classification. The nature of the breakdown was deduced from an examination of the broken pieces. The teeth were also sectioned along the middle so that any coronal leaking could be examined.

Statistical analysis

Marginal adaptation was compared among groups using the Kruskal-Wallis test, while starting and ending values were compared using the Wilcoxon signed-rank test. One-way analysis of variance was used to compare failure loads, and a t-test and Bonferoni correction for multiple testing were used in the post hoc analysis.



RESULTS

There is no loss of retention or fracturing of any of the teeth or restorations under thermomechanical strain. After analyzing marginal adaptation, it was shown that all groups' percentage of continuous margins reduced immediately after thermomechanical stress. When compared to the original copies, group III and IV showed much lower marginal adaptation, with group III displaying significantly weaker adaptation than the other groups. After undergoing thermomechanical stress, group IV (glass fiber posts) performed better than group III (endo crowns), and group IV was statistically more comparable to group V (zirconia oxide posts), while group VI (gold alloy posts) had a substantially smaller continuous margin.

All groups increased their continuous margin between the luting composite and crowns before undergoing thermomechanical stress. Group V (zirconia oxide posts) showed much less adaption of margins after thermomechanical stress. The proportion of continuous margin was much greater in groups III and IV than in groups V and VI.

Dye penetration

Table 1 displays the results of a dye penetration test. Tooth failure after endodontic treatment was investigated; causes included coronal leaking and hard tissue fractures. Composite resin endo-crowns and composite resin crowns supported by various post-and-core systems were placed on natural premolar and canine roots with comparable morphologies, and their adaptation in terms of margins, failure load, and type of failure were studied. The periodontal ligament was effectively imitated, root length was standardized, and ferrules were made for all groups. Before being loaded to failure in a universal test machine, each specimen was exposed to the identical oral load and thermocycling. The oblique direction of the load application is more destructive than the axial direction. Group II's load to failure did not vary from group I's untreated control group towards the

end of the research. Failure loads in groups III and IV were not significantly different from the control one, whereas failure loads in groups V and VI were significantly lower on average than the control one. Root fracture was the most common cause of tooth failure across all treatment groups, affecting around half of the teeth in each group. In the untreated control group, fracture occurred coronal to the cementoenamel junction. The lowest point of any crack was no more than 3 mm from the final cut. Group V and VI crowns broke and dislodged from the tooth without harming the tooth itself. Figure 3 depicts the many fracture types identified during the research.

DISCUSSION

The authors compared their findings to those of studies that examined the effects of root canal therapy on premolars and to studies that examined the effects of restoring premolars with gradual composite filling via a tiny access cavity. However, since the final restorations in the research were made out of composite resin, it is difficult to extrapolate the findings to other combinations, such as metal or ceramic crowns. The research showed that the (endo crown or glass fiberpost-supported crown) had a smaller adaptational margin than the all-ceramic and metal post and core systems. The composite resin (endo-crowns) exhibited the greatest degree of dye penetration, suggesting a larger proportion of bacterial leakage or secondary caries, and inadequate marginal adaptation after thermomechanical stress. Consistent with previous research, the maximum load values were reported for non endotreated teeth or root-canal-treated teeth with adhesively repaired access cavities. Results from the few studies that have looked at marginal adaptation of post-endodontic restoration after cyclic load stages are consistent with those found in the present investigation.

When compared to natural teeth, teeth that had been treated with resin composite (endocrowns or glass-fiber-post-reinforced composite resin crowns) had identical failure stresses. There was no statistically significant difference in the failure loads between teeth repaired with cast-gold or all-ceramic posts-supported crowns. The rigid core material, which did not conform to the stretching patteren of the composite resin crowns under stress, may account for the reduced failure loads seen for cast-gold and all ceramic posts-supported teeth. However, no one in either group had a vertical root fracture. Composite crowns were used because they reduced the force sent to the root via the rigid post, which may have resulted in more catastrophic failure with a crown constructed of metal or extremely high strength ceramic. Without a crown covering the repaired system, studies that loaded the cemented posts directly into the core cannot be compared to ours. Composite resin endo-crowns and glass-fiber-post-supported composite resin crowns did not vary more in fracture pattern in studies using crowns over after root canal treatment variations.

CONCLUSIONS

Most of the studies reviewed, endodontically treated incisors were examined, and the loads of failure were similar in three studies with a similar setup to this study. Teeth with the closed access cavity had the higher value, values were lower for teeth with composite resin restorations that extended just 3 mm into the enlarged root canal. Resin composite crown loads and failure modes were unaffected by post and core material, however all-ceramic, glass fiber, and cast gold posts improved marginal adaption. Root fractures and other visually obvious failure modes are more common when using metal or all-ceramic crowns than when using composite premolar crowns. Research using short glass-fiber posts to reduce hard tissue loss in severely injured premolars following root canal therapy should be conducted in the future to validate the outcomes of previous research using high-strength ceramics like lithium-disilicate or zirconia.

REFERENCES

1. Leary JM, Aquilino SA, Svare CW. An evaluation of post length within the elastic limits of dentin. Journal of Prosthetic Dentistry 1987;57:277–81.
2. Heydecke G, Butz F, Strub JR. Fracture strength and survival rate of endodontically treated maxillary incisors with approximal cavities after restoration with different post and core systems: an in-vitro study. Journal of Dentistry 2001; 29:427–33.
3. Sorensen JA, Engelman MJ. Ferrule design and fracture resistance of endodontically treated teeth. Journal of Prosthetic Dentistry 1990;63:529–36.
4. Isidor F, Brondum K, Ravnholt G. The influence of post length and crown ferrule length on the resistance to cyclic loading of bovine teeth with prefabricated titanium posts. International Journal of Prosthodontics 1999;12:78–82.
5. Christensen GJ. Post concepts are changing. Journal of the American Dental Association 2004;135:1308-10.
6. Bindl A, Mörmann WH. Clinical evaluation of adhesively placed Cerec endo-crowns after 2 years-preliminary results. Journal of Adhesive Dentistry 1999;1:255-65.
7. Göhring TN, Peters OA. Restoration of endodontically treated teeth without posts. American Journal of Dentistry 2003;16:313-7.
8. Bindl A, Björn R, Mörmann WH. Survival of ceramic CAD/CAM crowns bonded to preparations with reduced macroretention geometry. International Journal of Prosthodontics 2005;18:219–24.
9. Assif D, Bitenski A, Pilo R, Oren E. Effect of post design on resistance to fracture of endodontically treated teeth with complete crowns. Journal of Prosthetic Dentistry 1993;69: 36–40.
10. Trope M, Maltz DO, Tronstad L. Resistance to fracture of restored endodontically treated teeth. Endodontics and Dental Traumatology 1985;1:108–11.
11. Loney RW, Moulding MB, Ritsco RG. The effect of load angulation on fracture resistance of teeth restored with cast post and cores and crowns. International Journal of Prosthodontics 1995;8:247–51.
12. Krejci I, Duc O, Dietschi D, de Campos E. Marginal adaptation, retention and fracture resistance of adhesive composite restorations on devital teeth with and without posts. Operative Dentistry 2003;28:127–35.
13. Rosentritt M, Sikora M, Behr M, Handel G. In vitro fracture resistance and marginal adaptation of metallic and toothcoloured post systems. Journal of Oral Rehabilitation 2004;31:675–81.
14. Steele A, Johnson BR. In vitro fracture strength of endodontically treated premolars. Journal of Endodontics 1999; 25:6–8
15. Mannocci F, Ferrari M, Watson TF. Intermittent loading of teeth restored using quartz fiber, carbon-quartz fiber, and zirconium dioxide ceramic root canal posts. Journal of Adhesive Dentistry 1999;1:153–8.
16. Heydecke G, Butz F, Hussein A, Strub JR. Fracture strength after dynamic loading of endodontically treated teeth restored with different post-and-core systems. Journal of Prosthetic Dentistry 2002;87:438–45.
17. Pilo R, Cardash HS, Levin E, Assif D. Effect of core stiffness on the in vitro fracture of crowned, endodontically treated teeth. Journal of Prosthetic Dentistry 2002;88:302–6.
18. Butz F, Lennon AM, Heydecke G, Strub JR. Survival rate and fracture strength of endodontically treated maxillary incisors with moderate defects restored with different post-and-core systems: an in vitro study. International Journal of Prosthodontics 2001;14:58–64.
19. Akkayan B. An in vitro study evaluating the effect of ferrule length on fracture resistance of endodontically treated teeth restored with fiber-reinforced and zirconia dowel systems. Journal of Prosthetic Dentistry 2004;92:155–62.
20. Pontius O, Hutter JW. Survival rate and fracture strength of incisors restored with different post and core systems and endodontically treated incisors without coronoradicular reinforcement. Journal of Endodontics 2002;28:710–5.
21. Strub JR, Pontius O, Koutayas S. Survival rate and fracture strength of incisors restored with different post and core systems after exposure in the artificial mouth. Journal of Oral Rehabilitation 2001;28:120–4.
22. Sahafi A, Peutzfeldt A, Ravnholt G, Asmussen E, Gotfredsen K. Resistance to cyclic loading of teeth restored with posts. Clinical Oral Investigations 2005;9:84–90.