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Comparative evaluation of different restorative materials as an alternative to full coverage crown for endodontically treated teeth- An in-vitro study

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ABSTRACT:

Objectives- This study evaluated and compared the fracture resistance of different restorative materials as an alternative to full coverage crowns in endodontically treated teeth.

Methods and Materials- 40 freshly extracted mandibular premolars teeth were taken. Group A (n=10) was sound teeth. group B, C, D underwent access opening, biomechanical preparation and obturated using AH Plus sealer and GP. Group B (n=10) was then restored using Smart Dentin Replacement (SDR), Group C (n=10) with fibre reinforced composite EverX posterior and Group D (n=10) with Resin Modified GIC. The fracture resistance was evaluated with the help of Universal Testing Machine. The fracture resistance of groups were compared by using One-way ANOVA F test.

Results-results showed significantly different and higher fracture resistance of Group A and Group C in comparison to other groups.

Conclusion- Within the limitations of this study evaluated and compared to determine fracture resistance and comparison of Group A, B,C and D, it can be concluded fiber reinforced composite (Ever X Posterior, Group C) could be considered as an alternative to full crown coverage. **Keywords-** Fracture resistance, Ever X Posterior, Smart Dentin Replacement, Resin modified GIC, Full coverage Crown.

INTRODUCTION:

Success of an endodontically treated tooth is determined by its post-endodontic restoration. Post-endodontic restoration helps to maintain and protect the existing tooth structure, while restoring esthetics, function and form satisfactorily.⁽¹⁾ Endodontically treated nonvital teeth have higher potential to fracture as compared to vital teeth. Structure loss of tooth is caused by caries, access cavity preparation, trauma and radicular preparation. The fracture resistance of endodontically treated teeth is influenced by the effects of chemicals and intracanal medicaments. Endodontic access cavity preparations lead to increased cuspal deflection and increased risk of cusp fracture during function. Proprioception is impaired in endodontically treated teeth. The survival of root canal treated teeth is determined by the prognosis of root canal therapy, the amount of remaining dentine thickness and post-endodontic healing.⁽²⁾

Many clinicians have suggested full-crown coverage after the endodontic procedure. However, restoring a root canal– treated tooth to its original anatomy may aid in providing better strength and fracture resistance without placement of full-crown coverage restoration, which could provide economic benefits to the patients. Although full-crown coverage restoration has been advised as a means to strengthen a tooth after endodontic treatment, studies have reported incidences of tooth fractures despite the full-crown coverage placement.⁽³⁾ The main purposes of the final restoration of ETT are to avoid bacterial microleakage into the root canal system, restore form and function, preserve the remaining tooth structure, and maintain the integrity of periodontal health structure and esthetics⁽⁴⁾.

The search for an optimal restorative material capable of substituting lost dentine has driven significant advancements in dental materials research, leading to the development of a diverse array of options currently accessible to practitioners.. Three such groups of materials developed for the restoration of teeth that have undergone a significant loss of dentinal structures are bulk fill composite Smart dentin replacement material (SDR), short fibre reinforced resin-based composites (RBC), and resin modified GIC cement.

The material of choice for direct restorations of posterior teeth has always been Composite resin restorations given their mechanical properties, aesthetics and clinical performance. A recently introduced fiber-reinforced form of conventional dental composites called everX posterior has shown to improve

the resistance to occlusal load with short fibers. Studies have reported that there was a significant transfer of stress to the fibers which helped improve its material and mechanical properties.⁽⁵⁾ Along with this the incorporation of polyethylene fibers, nanohybrid composite and fiber reinforced composite could serve as an alternate to crown.⁽⁶⁾ SDR, which was developed especially for dentin replacement, can cure increments up to 4mm depth. The polymerization shrinkage had been reduced by more than 50% compared to conventional resin composites.⁽³⁾ Traditional GICs have been improved and modified by adding resin monomers (e.g. methacrylate groups) into the liquid components to form resin-modified GICs (RM-GICs). RM-GICs set by both the chemical and light curing polymerisation reactions. Composition of RM-GICs comprises of the polyacid salt matrix, the glass fillers, and the polymer chains. The strength of GICs is increased by the polymer chain structure which also reduces the water sensitivity of the materials.⁽⁷⁾

In current study fracture resistance test of materials were carried out with the help of Universal Testing machine.

MATERIAL AND METHOD:

40 intact freshly extracted mandibular premolars were collected. All the specimens were scaled to remove the adhering soft tissue and calculus and stored in saline. Teeth with caries, fracture were discarded. 10 intact teeth were used as control group A and endodontic access cavities were prepared in 30 teeth (Group B,C,D) using airotor hand piece and endo access bur and were enlarged till F1 Protaper Rotary file, followed by obturation with corresponding gutta percha using AH plus sealer (figure 1-2)

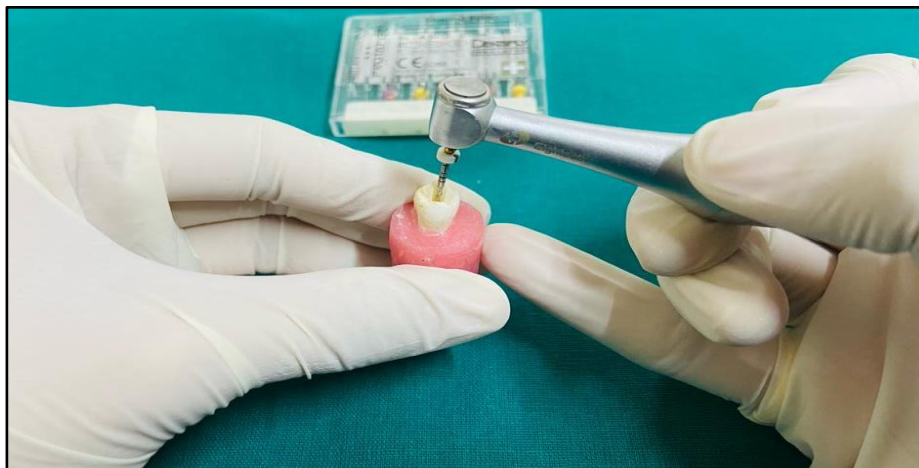
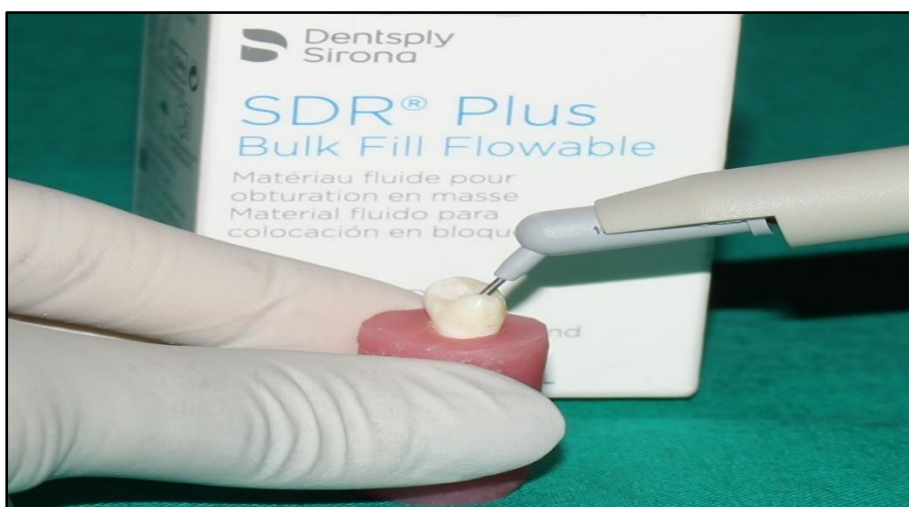


Figure 1: biomechanical preparation done till F1 Protaper Universal rotary system.



Figure 2: Obturation done using AH Plus sealer and master GP

In Group 2, endodontically treated teeth after obturation were etched using 37% phosphoric acid and bonding agent was applied and cured. A 4-mm increment-wise smart dentin replacement (SDR) was placed against the entire inner circumference of the remaining weakened tooth structure and was cured (figure 3).



In Group 3, endodontically treated teeth were etched using 37% phosphoric acid and bonding agent was applied and cured. The samples were restored using fibre reinforced composite everX posterior (figure 4).



In Group 4, endodontically treated premolars were restored with resin modified GIC as post-endodontic restoration material (figure 5).



Each tooth was encapsulated in a block of self-curing acrylic resin and subjected to a fracture resistance test by a universal testing machine (UTM). Static fracture resistance testing was completed using a UTM. A 5-mm diameter round tip stainless steel metal rod was fixed parallel to the long axis of the tooth

and was focalized on the center of the tooth until the bar just touched the occlusal surface as shown in Figure. Compressive loading of the teeth was operated at a crosshead speed of 1mm/min, and the force necessary to fracture each tooth was recorded in Newton (N). The results of this in vitro study were assessed statistically with Statistical Package for Social Sciences (SPSS) software, using one-way analysis of variance.

RESULT: The mean of the fracture resistance values and also the standard deviation and standard error for each of the groups are presented in Table 1.

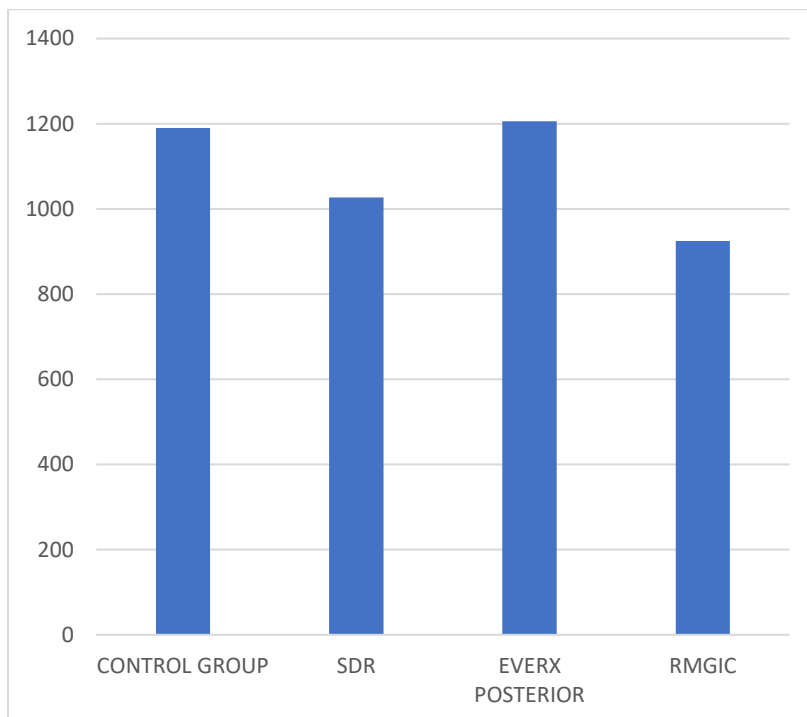


Table 1 : Overall comparison of fracture strength among four groups using One-way ANOVA F test

GROUP	MEAN	SD	UNPAIRED t TEST VALUE	P VALUE SIGNIFICANCE
Control group	1190.06	58.25	84.15	<0.001

SDR	1027.58	50.4	84.15	<0.001
EverX Posterior	1206.31	57.9	84.15	<0.001
RMGIC	925.90	112.6	84.15	<0.001

Figure 7 : : Mean and standard deviation values for fracture strength

In Group 1 (control), the mean fracture resistance value was observed as 1190.06N [Figure 7]. In Group 2 (SDR), the mean fracture resistance value was seen as 1027.58N [Figure 7]. In group 3 (EverX posterior), the fracture resistance value recorded was 1206.3N which was the highest when compared to all other experimental groups and in group 4 (RMGIC), the mean fracture resistance was observed as 925.90N which was the lowest value amongst all experimental groups.

DISCUSSION :

Endodontically treated teeth show loss of tooth structure due to caries, trauma and operative procedures, making the tooth more susceptible to fracture. Hence, root canal treated teeth need to be restored such that they would provide strength to the tooth. The success rate of root canal treatment is high, but if the coronal restoration is not appropriate, the endodontically treated teeth poorer prognosis. 59.4% of endodontically treated teeth have failed due to inappropriate coronal restoration, whereas only 8.6% because of poor quality of endodontic treatment⁽⁸⁾. Many studies have concluded that the most important factor determining the long-term survival of teeth following RCT is the timely placement of the final coronal restoration.⁽⁹⁾ Furthermore, premolars, with their anatomical characteristics including shape, crown-root ratio, and crown volume, were chosen as they are more prone to cuspal fractures, representing the worst-case scenario⁽¹⁰⁾.

Currently, the preferred choice of many dentists and patients for the coronal restorations is composite resin because of their sufficient retention and esthetic and mechanical properties with maximum conservation of tooth structure. The latter leads to cusp splinting/reinforcing effect which is due to result of their bonding ability to dental substrates⁽¹¹⁾.

Recently, advanced short-fiber-reinforced composite (SFRC) materials have been described as providing structural and chemical reinforcement to weaker teeth and have the potential to prevent fractures in Endodontically Treated Teeth. The short fibers in SFRC have been structurally oriented in such a way that, in combination with the composite resin matrix, they allow for more constrained crack propagation following force application preserving the tooth from catastrophic failures more efficiently.⁽¹²⁾ EverX posterior has the highest fracture resistance among the composite materials used in this study due to incorporation of E -Glass fibers and barium borosilicate fillers. The total inorganic fiber and filler content is 77% by weight. EverX posterior is an anisotropic material and its properties differ depending on the dimension in which they are observed. When fibers are orientated on a plane, the horizontal shrinkage, which is controlled by the direction of the fibers, will be different from the vertical shrinkage. As a result, during polymerisation reaction, everX posterior material cannot shrink along the length of the fibers⁽⁵⁾.

Development of SDR was done specially for dentin replacement and its ability to cure increments up to 4 mm depth. There has been more than 50% reduction in polymerization stress as compared to conventional resin composites⁽¹³⁾. SDR is incorporated with a modulator called urethane dimethacrylate which interacts with the camphorquinone photoinitiator during polymerization to reduce the speed of elasticity modulus development⁽¹⁴⁾. Additionally, self-leveling behavior and better adaptation to cavity walls is because of its altered rheology facilitating faster completion of the restorative procedure⁽¹⁵⁾.

Hydrophilic resin monomers have been incorporated into an aqueous solution of polyacrylic acid which has led to the development of resin-modified glass-ionomer material (RMGI). RMGIC has shown superior mechanical properties, easy handling, and improved esthetic results facilitating their use in the permanent dentition⁽¹⁶⁾. However, the presence of resin monomers may affect the biological properties of RMGICs, especially with regard to their biocompatibility.⁽¹⁷⁾

Popularity of Direct composite restorations is because of their aesthetic and improved mechanical properties, simple application, and the fact that they can be placed in a single session. Many studies have shown that restoration with composite resins placed in increments and bulk exhibited significantly different mean fracture resistance in endodontically treated premolars.⁽¹⁸⁾

These recently advanced and new restorative materials with unique techniques helps the dental practitioner to tackle existing problems from a different perspective, and thereby achieve an innovative solution. Although due to lack of

literature and evidence to support or negate the reliability of conventional restoration over full-crown coverage of endodontically treated teeth, decision taken by clinicians should be decided on their clinical expertise as well as the economic status of the patient. The most important factor which influences the long term survival rate of endodontically treated teeth is the choice of restorative material and the amount of remaining tooth structure.⁽¹⁹⁾ fibre reinforcement of Resin-based composite can be considered as an efficient direct restorative approach for coronal restorations of posterior teeth, especially with extensive cavity preparations in high-stress bearing intra-oral areas.⁽²⁰⁾

CONCLUSION:

Within the limitations of this in vitro study, titled “Comparative evaluation of different restorative materials as an alternative to full coverage crowns for endodontically treated teeth: An in-vitro study” evaluated and compared the fracture resistance of short fiber reinforced composite Ever X posterior, bulk fill composite Smart Dentin Replacement (SDR) and Resin Modified GIC. It can be concluded that fiber reinforced composite could be considered as an alternate to crown coverage in endodontically treated teeth due to the random fiber orientation of e-glass fillers which effectively prevented polymerization shrinkage, crack propagation, and evenly distributed stress.

REFERENCES:

1. Bejoy BM, Anitha S, George L. Conservative Bonded Restoration (An Alternative to Full Coverage Crown): A Case Report on Endocrown. *Cons Dent Endod J* 2020;5(2):42–47.
2. Systematic review fracture resistance of endodontically treated posterior teeth restored with fiber reinforced compositesa systematic review Harish Selvaraj1 , Jogikalmat Krithikadatta2* , Deepti Shrivastava3 , Meshal Aber Al Onazi4 , Hmoud Ali Algarni4 , Swapna Munaga5,6 , May Osman Hamza7 , Turki saad Al-fridy8 , Kavalipurapu Venkata Teja9 , Krishnamachari Janani10 , Mohammad Khursheed Alam3,11,12 and Kumar Chandan Srivastava13,14
3. Magaravalli SR, Patel S, Rangaswamy P, Ramachandra S, Govindappa K, Hiremath V. Effect of smart dentin replacement, biodentine, and its combination for dentin replacement as alternatives to

- full-crown coverage for endodontically treated molars: An in vitro study. J Int Soc Prevent Communit Dent 2019;9:559-65.
4. Alhamdan M M, Aljamaan R F, Abuthnain M M, et al. (August 24, 2024) Direct Versus Indirect Treatment Options of Endodontically Treated Posterior Teeth: A Narrative Review. Cureus 16(8): e67698. DOI 10.7759/cureus.67698
 5. Kamath AK, Kudva AR, Eram A, et al. Comparative Evaluation of Fracture Resistance of Posterior Teeth Restored Using Three New Composite Materials: An In Vitro Study. World J Dent 2023;14(7):608–612.
 6. Sharma A, Gupta V, Rajkumar B, Bhatt A, Nigam A. A Comparative evaluation of different restorative materials as an alternative to crown coverage for endodontically treated mandibular molars An in-vitro study. J Adv Med Dent Scie Res 2020;8(3):82-87
 7. Glass-ionomer cement: from basic knowledge to application for coronal seal in endodontic treatment: a narrative review Danuchit Banomyong Dental Department, Sukhumvit Hospital, Bangkok, Thailand, 10110
 8. Arya, A. ., Grewal, M. S. ., Arya, V., Choudhary, E., Jain, S., & Duhan, J. (2022). Coronal restoration of endodontically treated posterior teeth: A review. International Journal of Health Sciences, 6(S1), 10319–10329.
 9. Direct Versus Indirect Treatment Options of Endodontically Treated Posterior Teeth: A Narrative Review Mai M. Alhamdan , Rodina F. Aljamaan , Munira M. Abuthnain , Shahd A. Alsumikhi , Ghada S. Alqahtani , Reem A. Alkhraiyeef
 10. Selvaraj H, Krithikadatta J (August 01, 2023) Fracture Resistance of Endodontically Treated Teeth Restored With Short Fiber Reinforced Composite and a Low Viscosity Bulk Fill Composite in Class II Mesial-Occlusal-Distal Access Cavities: An Ex-vivo Study. Cureus 15(8): e42798. DOI 10.7759/cureus.42798
 11. Fracture resistance of endodontically treated premolars restored with bulk-fill composite resins: The effect of fiber reinforcement Fereshteh Shafiei, Paria Dehghanian, Nasibeh Ghaderi, Maryam Doozandeh Department of Operative Dentistry, Oral and Dental Disease Research Center, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran.
 12. Caussin, E.; Izart, M.; Ceinos, R.; Attal, J.-P.; Beres, F.; François, P. Advanced Material Strategy for Restoring Damaged Endodontically Treated Teeth: A Comprehensive Review. Materials 2024, 17, 3736.
 13. Shear bond strength of different dentin substitute restorative materials to dentin of primary teeth Faika ABDELMEGID1 , Fouad SALAMA2 ,

Nawaf ALBOGAMI³ , Muhannad ALBABTAIN³ and Abdulkareem ALQAHTANI³

14. Present status and future directions: The restoration of root filled teeth
Francesco Mannocci¹ | Kerstin Bitter² | Salvatore Sauro³ | Paolo Ferrari⁴
| Rupert Austin⁵ | Bhavin Bhuva¹
15. Choudhury WR, Nekkanti S. Mechanical Properties of SDR™ and Biodentine™ as Dentin Replacement Materials: An In Vitro Study. *J Contemp Dent Pract* 2022;23(1):43–48.
16. Evaluation of the Mechanical Properties of Three Resin-Modified Glass-Ionomer Materials Heleine Maria Chagas Rêgo, Sheila Butler, and Maria Jacinta Coelho Santos
17. Ghilotti, J.; Mayorga, P.; Sanz, J.L.; Forner, L.; Llana, C. Remineralizing Ability of Resin Modified Glass Ionomers (RMGICs): A Systematic Review. *J. Funct. Biomater.* 2023, 14, 421.
18. Gheorghe, G.F.; Tâncu, A.M.C.; Amza, O.E.; Suciuc, I.; Iosif, L.; Cuc, S.; Petean, I.; Moldovan, M.; Dimitriu, B. Influence of Direct Coronal Restoration Materials on the Fracture Resistance of Endodontically Treated Premolars: An In Vitro Study. *Dent. J.* 2024, 12, 294.
19. Fedorowicz Z, Carter B, de Souza RF, Chaves CA, Nasser M, Sequeira-Byron P. Single crowns versus conventional fillings for the restoration of root-filled teeth. *Cochrane Database Syst Rev* 2012;16:CD009109.
20. Escobar, L.B.; Pereira da Silva, L.; Manarte-Monteiro, P. Fracture Resistance of Fiber-Reinforced Composite Restorations: A Systematic Review and Meta-Analysis. *Polymers* 2023, 15, 3802