Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2019;10:1:151-155.

Fracture Resistance Analysis of Different Adhesive Access Restorative Materials Using Universal Testing Machine: An In-Vitro Study

Swathi K[1*] Kiran Kumar N[2] Savitha B Naik[3] Seema Merwade[4] Biji Brigit K[5] Saranya Ramachandran[6]

[1]PG Student, Department of Conservative Dentistry & Endodontics, Government Dental College and Research Institute, Bangalore, Karnataka, India.

[2]Professor and Head, Department of Conservative Dentistry & Endodontics, Government Dental College and Research Institute, Bangalore, Karnataka, India.

[3]Associate Professor, Department of Conservative Dentistry & Endodontics, Government Dental College and Research Institute, Bangalore, Karnataka, India.

[4]Associate Professor, Department of Conservative Dentistry & Endodontics, Government Dental College and Research Institute, Bangalore, Karnataka, India.

[5]Associate Professor, Department of Conservative Dentistry & Endodontics, Government Dental College and Research Institute, Bangalore, Karnataka, India.

[6]PG Student, Department of Conservative Dentistry & Endodontics, Government Dental College and Research Institute, Bangalore, Karnataka, India.

ABSTRACT

Aim: To compare the fracture resistance of endodontically treated tooth with five different restorative material as access cavity restoration

Materials and methodology: 108 single rooted extracted premolars were divided into 6 groups, with 18 teeth in each group. All the premolars excluding the control group were subjected to class 2 access cavity preparation of specific dimension, biomechanical preparation and obturation with single cone method. Following endodontic procedure, each group was restored with specific access restorative materials- Group A- Bulk fill composites, Group B – Ketac Molar GIC, Group C – Zirconomer, Group- D – Giomer and Group E – Equia Forte GC respectively. Group F (control)-sound teeth. The teeth were subjected to thermocycling for 7 days at 37ºC. Fracture resistance was measured using Universal Testing Machine at a cross head speed of 1mm/min.

Results: Statistical analysis was done using One way Anova and post hoc Tukey's test. There was statistically significant differences among the groups ($p<0.001$). Sound teeth exhibited the highest fracture resistance(- 1161.10 ± 58.74 N).Among the restorative materials Bulk fill composite resulted in highest fracture resistance (mean value- 716.75 ± 99.87 N) and Ketac molar the least (- 339.31 ± 79.31 N).

Conclusion: Preservation of marginal integrity plays an important role in fracture resistance of teeth. Within the limitations of the study bulk fill composite can be regarded as best suited material for access restoration in posterior teeth.

Keywords: Fracture resistance, Bulk fill composite, Zirconomer, Giomer.

INTRODUCTION

Endodontic treatment is said to be complete when final coronal restoration is placed. The access preparations for endodontic treatment result in increased cuspal deflection during mastication,

Received: Sept. 5, 2019**:** **Accepted**: Oct. 17, 2019

***Correspondence Dr. Swathi K.**
Department of Conservative Dentistry & Endodontics, Government Dental College and Research Institute, Bangalore, Karnataka, India.
Email: swathikmanjeshwaram98@gmail.com

pISSN 2278-0076
eISSN 2321-9270

increasing the potential for fracture and microleakage at restoration margins. Initially, the dentin in endodontically treated teeth were thought to be more fragile due to dehydration nd collegen crosslinking degradation. Studies, however favour the interpretation because it leads to a higher occurrence of fractures in endodontically treated teeth relative to " vital " teeth.[1]

Final restoration for a root filled tooth retains appearance and function, protects the residual structure of the tooth and avoids microleakage.[2] Thus, effective postendodontic restoration is a crucial final step towards success of root canal treatment.

The choice of appropriate restoration for endodontically treated teeth depends mainly on the remaining coronal tooth structure in addition to the functional requirements of the tooth.[3] It is well documented that coronal coverage significantly improve the survival rate of endodontically treated molar and premolar teeth if there is extensive loss of tooth structure.[3-5]

Because of their structure and the occlusal forces placed on them during function, posterior teeth present different restorative needs. There have been many attempts to replace the conventional cast restoration with different restorative materials, but very few restorations have been objectively evaluated. Amalgam, for instance, the most common material used for more than 100 years that does not conform to the dental structure, has become one of the main drawbacks for restoration failure. Introduction of new bonding agents with bond strength between 20 and 25 MPa (and sometimes even more) has led to the possibility of restoring endodontically treated teeth with bonded restoration instead of crown or onlay. Such bonding agents have the advantages of providing greater strength and resistance to fractures without placing full coverage restoration and also minimizing coronal microleakage that may result as an important factor in the selection of bonding agents for the coronal buildup of endodontically treated teeth. Such property of a restorative material will provide patients with possible prosthodontic and economic benefits. For these purposes, the use of adhesive materials have been considered useful for tooth reinforcement. With the recent advancements in adhesive science and stronger adhesive materials, it is now possible to create conservative, yet highly cosmetic restorations that are attached directly to the tooth structure and reinforce it.[6]

Adhesive materials like resin-based composites and type 2 GIC, are tried tested with various modifications in their compositions to achieve a strongest material for restoration of endodontically treated teeth. But no material is determined as the best access restorative material, since modifications and advancements keep increasing in all restorative materials. Hence, the current research is done to evaluate the fracture resistance of endodontically treated teeth restored with five tooth colored restorative materials i.e., Bulk fill posterior composites, Type 2 Restorative GIC (Ketac Molar Restorative GIC), Zirconomer, Giomer and Equia Forte.

MATERIALS AND METHODS

108 extracted single rooted premolars were collected. Only those teeth that were extracted for orthodontic purpose was included. Teeth with dental caries, malformation, fracture and restoration were excluded. All the teeth were randomly divided into 6 experimental groups with 18 teeth in each group. Teeth in 5 groups were subjected to the following procedures: Class II (MO or DO) cavities were prepared with access opening bur. The proximal boxes were prepared straight and limited to 2 mm coronally in the depth from the cementoenamel junction. Standard endodontic access cavities were prepared. Cleaning and shaping of root canals were done to size F2 and filled with 25 size gutta-percha using single cone technique. After root canal treatment, the teeth in each group were restored with following materials: Group A- Bulk fill composite (Ivoclar bulk fill), Group B- Ketac molar Glass ionomer cement (3 M ESPE), Group C- Zirconomer (Shofu Inc., Japan), Group D- Giomer (Beautiful- bulk restorative, Shofu.Inc., Japan), and Group E- Equia Forte GIC., all the materials were manipulated according to respective manufacturer's instructions. Group F(Control): unaltered teeth.

Teeth were subjected to thermocycling at 37° C for seven days. Cylindrical moulds of size 2.5 cm × 2.5 cm were made using stainless steel pipes. Self-cure acrylic resin was used to fill the mould and the teeth was mounted to 1 mm apical to the cementoenamel junction. Universal Testing Machine was used to measure fracture resistance at a cross head speed of 1 mm/min.

RESULTS

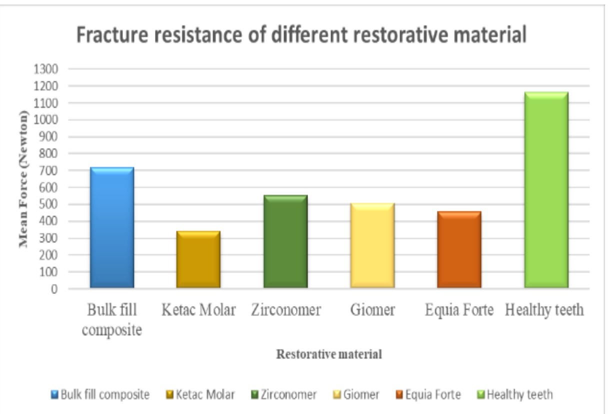
Results were stastically analysed. Multiple group Comparison was done using one-way ANOVA followed by Tukey's test for group-wise comparisons.

Table 1: Shows the mean fracture resistance and standard deviation of different groups.

Samples	Bulk fill composite	Ketac Molar	Zirconomer	Giomer	Equia Forte	Healthy teeth (controls)	p value
Mean force (Newton)	716.75 ± 99.87	339.31 ± 79.31	550.41 ± 121.10	504.14 ± 113.03	453.93 ± 105.82	1161.10 ± 58.74	<0.001

Multiple group analysis done by one way ANOVA revealed that different restorative materials and techniques significantly affected the fracture resistance in different groups (p<0.001). Tukey's test showed that the mean fracture resistance of Natural teeth was significantly highest followed by Bulk Fill composite when compared to other groups. The mean fracture resistance of Zirconomer was almost equal to that of Giomer and significantly higher than that of Equia Forte. Also the mean fracture resistance of Giomer and Equia forte were almost equal with no statistically significant difference.

Fig 1: Fracture resistance of different restorative material



DISCUSSION

Entrance filling of root canal treated teeth is regarded as a very important final step which will enhance the success of endodontic treatment.[2] Hence endodontic therapy is said to be complete only after the placement of final restoration. It is now possible to restore endodontically treated teeth with bonded restorations due to the advent of bonding agents rather than a complete coverage restoration. This provides a potential for prosthodontic and economic benefits to patients.[7] The present research was therefore carried out to assess the fracture resistance of endodontically treated premolar teeth restored with five different restorative materials, i.e., Bulk fill composite, type 2 restorative GIC, zirconomer, Giomer and Equia Forte (GIC).

Statistically the present study, unveiled that, sound natural teeth sustained highest fracture resistance with a mean force of 1161N when compared to all the other restored teeth. This observation is in agreement with that of a study, where E. S. Reeh et al (1989)[8] has concluded that endodontic procedure reduces tooth stiffness by only 5%. This reduction is mostly due to the access opening, and that an MOD cavity can reduce the stiffness to about 60% or more. Thus, we can say that the reduced fracture resistance in root canal treated teeth can be attributed to loss of marginal integrity. Monga P et al (2009)[9] also concluded that sound teeth sustained highest fracture resistance, supporting the fact that teeth are weakened by the removal of tooth structure.

Teeth restored with Tetric Evoceram Bulk fill composite with filler content 61Vol% showed highest fracture resistance with mean value of 716.75N when compared to remaining restorative materials. It is a well known fact that when composite restoration is done, there is stress generation and inward deformation of the cavity walls of restored teeth. This is due to the volumetric contraction and solidification that occurs during the polymerization of composite resins. In a study, C. M. P. Rosatto et al (2015)[10] through finite element analysis it was found that lower stress was developed in bulk fill composites when compared to incremental technique.

The use of bulkfill composite resins in posterior restorations has been shown to reduce cusp deformation, postgel shrinkage, and shrinkage stress, and, also increase in fracture resistance when compared to conventional composites. These findings can be correlated with the results of this study.

Mohanty S et al (2017)[11] had also concluded that bulk fill composite resin can withstand higher compressive stress when compared to dental amalgam and zirconomer. The present study has shown similar results which can be attributed to the better polymerization due to the presence of Ivocerin, which increases the depth of cure without incremental technique.

Zirconomer showed better fracture resistance when compared to Ketac Molar, Giomer and Equia Forte with mean value of 550.41N. It was concluded by Challlissery VP et al (2016)[12] that the zirconia reinforced GI can be a material of choice in loadbearing areas. This finding can be attributed to the improved mechanical properties of Zirconomer due to the presence of zirconia as filler component in the material. This zirconia reinforces the structural integrity of the restoration. Kamath U et al (2016)[13] had tested the fracture resistance of maxillary premolars with MOD cavities restored with Zirconia reinforced Glass Ionomer Cement (Zirconomer) and concluded that Zirconomer have better strength than the conventional posterior restorative materials. It can be said that the findings of the above studies may be contributory factors to the present study, which also gave similar results.

Giomer had shown a mean value of 504.14N which was higher than Ketac Molar and Equia Forte, which correlates with one of the studies. According to Walia R et al (2016)[14], resin based PRG fillers and cross linked polymer matrices of giomer resulted in the higher fracture resistance than the acid base reaction in glass ionomers. No significant differences were seen between Zirconomer and Giomer. This finding again is in concurrence with superior qualities of Zirconomer and Giomer when compared to conventional glass ionomer.

Equia Forte and Ketac Molar resulted in least values of fracture resistance with Equia forte being a better restorative material when compared to Ketac molar. This finding is in agreement with the one of the study done where Equia forte was determined to have better fracture resistance when compared to other glass ionomer cements.[15] The GC company claims Equia Forte to be one of the best alternative to conventional GIC, due to its glass hybrid filler technology. Poor mechanical properties of glass ionomer cement like low fracture strength, toughness and higher occlusal wear rate can be attributed for the low values of compressive strength of Ketac Molar Glass ionomer cement.[16] Hence based on the results of current study it can be said that conventional glass ionomer is not a material of choice as entrance filling.

It should also be considered that the force applied on the specimen was constant in nature and cannot be directly compared to the forces subjected to any restorative material in the oral cavity. The position of the teeth and the direction of the force plays an important role in determining the fracture resistance of a restorative material. The amount of tooth structure lost and the bond strength of the restorative materials are other key factors which play a vital role in the survival of restorations. Hence, further in vitro and in vivo studies is required to generalize the results of current research.

CONCLUSION

Within the limitations of the current study, we can conclude that the restored teeth had a lower fracture resistance when compared to sound natural teeth. Bulk fill composites proved to be the best access restorative material with statistically significant higher results, followed by Zirconomer and Giomer. Newer product called Equia Forte by GC Company have unveiled to be a promising new innovation in glass ionomer when compared to Ketac Molar glass ionomer and hence can be used as a choice of material in cases where type 2 GIC is preferred. Even so, no single material can be declared to be the best as science is always in a hunt to produce newer products by overcoming the pitfalls of existing restorative materials. Based on current evidences, endodontically treated teeth with not so significant tooth structure loss can be restored with adhesive materials and thus reducing the time and cost required for the treatment. Thus, it is in clinicians hand to decide the best material based on existing evidence.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Richard S. Schwartz, DDS, and James W. Robbins, DDS, MA Post Placement and Restoration of Endodontically Treated Teeth: A Literature Review. Journal of endodontics.2004;30(5).

2. Hürmüzlü F, Serper A, Siso SH, Er K. *In vitro* fracture resistance of root filled teeth using new generation dentine bonding adhesives. Int Endod J 2003; 36: 770-3.

3. Sorensen JA, Martinoff JT. Intracoronal reinforcement and coronal coverage: a study of endodontically treated teeth. The Journal of Prosthetic Dentistry 1984; 51: 780–4

4. Salehrabi R, Rotstein I. Endodontic treatment outcomes in a large patient population in the USA: an epidemiological study. Journal of Endodontics 2004; 30: 846–50

5. Aquilino SA, Caplan DJ. Relationship between crown placement and the survival of endodontically treated teeth. The Journal of Prosthetic Dentistry 2002; 87: 256–63.

6. Steele A, Johnson BR. *In vitro* fracture strength of endodontically treated premolars. J Endod 1999;25:6-8

7. Riswana NA, Kumari VA. Comparison of Fracture Resistance of Endodontically Treated Tooth with Composite and GIC as Entrance Filling-An In Vitro Study. J. Pharm. Sci. & Res. 2015;7(11):984-986.

8. Reeh ES, Douglas WH, Messer HH. Stiffness of endodontically treated teeth related to restoration techniques. J Dent Res 1989; 68(11): 1540-4

9. Monga P, Sharma V, Kumar S. Comparison of fracture resistance of endodontically treated teeth using different coronal restorative materials: An *in vitro* study. J Conserv Dent. 2009;12(4):154-9

10. C.M.P. Rosatto, et al., Mechanical properties, shrinkage stress, cuspal strain and fracture resistance of molars restored with bulk-fill composites and incremental filling technique, Journal of Dentistry. 2015.

11. Mohanty S, Ramesh S. Fracture resistance of three posterior restorative materials: A preliminary *in vitro* study. J Adv Pharm Edu Res 2017;7(3):291-294.

12. Chalissery VP, Marwah N, Almuhaiza M, alzailai AM, Chalisserry EP, Bhandi SH, Anil S. Study of the Mechanical Properties of the Novel Zirconia-reinforced Glass Ionomer Cement. J Contemp Dent Pract 2016;17(5):394-398.

13. Kamath U, Salam A. Fracture resistance of maxillary premolars with mod cavities restored with Zirconomer: An *in vitro* comparative study. International Journal of Applied Dental Sciences 2016; 2(2): 77-80.

14. Walia R, Jasuja P, Verma KG, Juneja S, Mathur A, Ahuja L. A comparative evaluation of microleakage and compressive strength of Ketac Molar, Giomer, Zirconomer, and Ceram-x: An in vitro study. J Indian Soc Pedod Prev Dent 2016;34:280-4

15. Glavina D, Gorseta K, Skrinjaric T. Compression Fracture Resistance of Four Different Glass-Ionomer Cements. ConsEuro 2015.

16. Lohbauer U. Dental Glass Ionomer Cements as Permanent Filling Materials? —Properties, Limitations and Future Trends. Materials 2010; 3: 76-96.