Journal of Cardiovascular Disease Research
ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 11, 2024

Evaluation of different fibers and biodentine as alternates to crown coverage for endodontically treated molars: An in vitro study

Dr.Vartika Parasrampuria[1] Dr.Asheesh Sawhny[2] Dr.Annu Kushwaha[3] Dr.Prateek Singh[4] Dr.Deeksha Dubey[5]

[1]Post Graduate Student, Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, Uttar Pradesh, India.
[2]Principal and head, Department of conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, UP, India.
[3]Reader, Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, UP, India.
[4]Reader, Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, UP, India.
[5]Senior lecturer, Department of conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre Kanpur, UP, India.

Abstract:
Objective: This study aims to assess the fracture resistance of more recent restorative materials that may be used as a crown coverage substitute.
Materials and Methods:
Forty extracted human mandibular molar teeth were selected for this study and were divided into four groups (n = 10). All the teeth in the experimental groups (Group 2–4) were subjected to access cavity preparation with roughly 1.5 mm of tooth structure remaining throughout the circumference.
Group 1: Intact teeth used as control.
Group 2: Access cavities reinforced with biodentine.
Group 3: Inner circumference of access cavities reinforced with Glass fiber and nano-hybrid composite.
Group 4: Access cavities were reinforced with fiber reinforced composite. All the teeth were subjected to fracture resistance using universal testing machine.
Results: The Tukey post hoc test and one-way ANOVA were used to statistically assess the study's findings. Group 2 differed considerably from the control and other experimental groups and showed the lowest mean values of fracture resistance. There was no statistically significant difference between Groups 1, 3, and 4.
Conclusion: It is possible to conclude that glass fiber with nanohybrid composite and fiber reinforced composite could be used as alternatives to crown covering within the constraints of this in vitro investigation.

INTRODUCTION

One of the most researched and contentious issues in dentistry is the restoration of teeth that have received endodontic therapy. The optimal clinical techniques and materials for restoring fractured teeth are still up for debate. Teeth lacking vital pulps are more likely to fracture than teeth with them, despite some authors showing a slight difference in the frequency of fractures between Chinese patients' non-endodontically treated and endodontically treated teeth.[1] Research indicates that teeth that have undergone endodontic treatment have a significantly altered dentin and are thought to be more brittle than teeth that are still healthy due to the absence of water and collagen cross-linking.[2] Dehydration

and endodontic treatment had little effect on dentin, according to earlier research that evaluated the mechanical and physical characteristics of dentine specimens[3]

Endodontic tooth restoration is a standard procedure in clinical practice. Even though this subject has been well researched, identifying the best effective form of restorative therapy has proven difficult. [4]

There has long been discussion about whether full cast crowns are required following endodontic treatment, particularly for posterior teeth. Crown implantation has not stopped tooth fractures, despite the fact that crown restoration has been proposed as a way to fortify a tooth following endodontic therapy.[5] To determine if cutting-edge restorative materials would make a suitable replacement for crown covering, an in vitro investigation was conducted. The current study examines the fracture resistance of mandibular molars that have undergone extensive access cavity preparations and endodontic treatment and have been replaced with three distinct restorative materials.

MATERIALS AND METHOD

Forty whole, non-carious mandibular molars that had been removed for periodontal reasons were collected for this in vitro study. After being examined under an operating microscope (Labomed Inc., Los Angeles, USA) at ×12.8 magnifications to rule out any problematic teeth, only healthy teeth free of fractures or fracture lines were selected for the investigation. The teeth were preserved with physiological saline until the examination was finished. To ensure consistency and lessen the effect of size and shape variations on the results, the teeth were selected based on their buccolingual (9 ± 1 mm) and mesiodistal (10 ± 1 mm) dimensions. After that, they were divided into four groups of ten teeth each at random.

Group 1: The teeth in this group served as controls and were not exposed to biomechanical or access cavity preparation. Access cavity preparation was performed on all of the teeth in the experimental groups (Groups 2–4), leaving around 1.5 mm of tooth structure intact around the periphery. In order to replicate access preparations in teeth with significant occlusal caries, this preparation was carried out. Every experimental tooth's canal was created to size F1 using ProTaper Rotary (Dentsply, Mumbai, India), and the corresponding ProTaper gutta-percha (Dentsply, Mumbai, India) and AH Plus (DeTrey, Switzerland) sealers were used to obturate the teeth.

In **Group 2**: the access cavities were restored with biodentine as post obturation restoration.

In **Group 3**: the access cavities were conditioned with 37% phosphoric acid (3M ESPE, Bangalore, India) and bonding agent applied (Adper, 3M ESPE, Bangalore, India) and cured according to manufacturer's instruction. A strip of premeasured Glass fiber (Everstick, GC ,GC America) was placed against the entire inner circumference of the remaining weakened tooth structure with the help of a thin layer of flowable posterior composite (G-ænial Universal Flo, GC India). Later, the entire access cavity was filled with nanohybrid composite (Nexcomp, METABIOMED, Chungbuk, Korea South).

In **Group 4,** the same protocol of etching and bonding was performed as that of Group 3, but the access cavity was restored with fiber reinforced posterior composite material (everX Posterior, Dentsply, Mumbai, India) as base and occlusal 1 mm layer of Filtek Z350 XT (3M ESPE, Bangalore, India) was placed to achieve better finishing and polishing to simulate the clinical situation. Each tooth was lodged in a block of self-curing acrylic resin (Tempron, GC India) with its long axis perpendicular to the block's base after being covered with a coating of polyvinyl siloxane impression material (EXAFLEX, GC America Inc., USA). Until they were tested for fracture resistance, all of the teeth were kept in an incubator at 37°C and 100% humidity. Using a universal testing machine (Instron India Pvt Ltd., Chennai), static fracture resistance testing was carried out.

A 5 mm round-tipped stainless steel rod was positioned parallel to the teeth's long axis and centered over the teeth until the bar barely touched the occlusal surface. When the teeth were crushed at a crosshead speed of 1 mm/min, the force needed to break each tooth was measured in Newtons. The results of the investigation were statistically examined using SPSS 11.5 statistical software (SPSS Corp., Chicago, IL, USA). One-way ANOVA and the Tukey post hoc test were employed. P values at the 0.05 level of statistical significance were computed and compared.

RESULTS

[Table 1] shows the standard deviation and mean of the fracture resistance values for each group. Group 4's mean fracture resistance value was somewhat greater than Group 3's mean value. Group 1 (intact tooth specimens) had a greater mean fracture resistance value than the other groups. In comparison to the control and other experimental groups, Group 2 showed the lowest mean value of fracture resistance. There was no discernible change between Groups 1, 3, and 4.

{Table 1}

Groups	Group 1	Group 2	Group 3	Group 4
Mean	2257.70	834.20	1890.80	1946.10
SD	719.16	298.29	612.19	652.04
SE	227.41	94.32	193.59	206.19
Group 1	-	-	-	-
Group 2	P=0.0002*			
Group 3	P=0.5175	P=0.0018	-	-
Group 4	P=0.6462	P=0.0011*	P=0.9968	P=0.9968

*(The mean difference is significant at the 0.05 level. SD: Standard deviation, SE: Standard error)Table 1: Comparison of fracture resistance among experimental group

DISCUSSION:

When choosing the type of restorative material and restoration procedure for endodontically treated teeth, the remaining coronal tooth structure and functional requirements are critical factors.[6] In restorative dentistry, it has been demonstrated that all occlusal cavity preparations lose fracture resistance proportionate to their breadth.[7] Later, a similar idea was proposed for endodontics, indicating that the cuspal deflection increased proportionately with the size of the cavity and was highest when an endodontic cavity was present.[8]

In order to increase the fracture resilience of teeth with root fillings, Clark and Khademi [9] have recently proposed a modified endodontic cavity idea that involves removing very little tooth material. The large access cavity preparation technique used in our investigation replicated a clinical scenario of severe caries. The restoration of an endodontically treated tooth was formerly accomplished by an experimental exercise, the outcome of which was not always predicted.[10] Nonvital and root canal-treated teeth lose their structural integrity, which can lead to tooth breakage.[11] More preparation, particularly the elimination of marginal ridges, resulted in the most decrease in tooth stiffness.[12]

A retrospective cohort study by Nagasiri and Chitmongkolsuk indicated that endodontically treated molars that are intact (except for the access opening) could be restored successfully using composite restorations.[13] Another study compared the clinical success of 1273 endodontically treated anterior teeth with a follow-up of 25 years. It was concluded that coronal

coverage crowns did not significantly improve the fracture resistance.[14] A finite element analysis study was conducted by Zelic et al. to determine weakening of the tooth regarding extent of cavity preparation. They concluded that access cavity preparation had the greatest influence on tooth strength while canal enlargement did not contribute to this process significantly.[15]

The goal of the current investigation was to determine whether an alternative to crown coverage might be used to strengthen a tooth that has undergone endodontic treatment by simulating a significant loss of crown structure as a result of caries. Mandibular molars were chosen for this in vitro investigation based on their function and position inside the arch.[16] The solid foundation needed for tooth repair is provided by the residual dentin thickness.

Because the quality and integrity of its anatomic shape determine its structural strength, the fundamental issue is that there is less healthy dentin left to support and hold the restoration in place.[1] Therefore, the key to successful restorative dentistry is choosing the right restorative material and procedure to make up for the loss of coronal tooth structure.

As demonstrated in earlier research, the teeth's strength was considerably diminished in this study following access cavity preparation.[6], [12] To sustain the remaining tooth structure, the access cavity must be reinforced with a restorative substance. Since biodentine is thought to be a dentine substitute, it was selected as one of the post-endodontic restorative materials.

It sets within 12 min, which facilitates its use in immediate crown restoration. Its properties such as elastic modulus, compressive strength and micro hardness is very similar to that of natural dentin. It exhibits good bacterial tight seal with the margins of the tooth structure.[17] Furthermore, in a study by Koubi et al.,[18] Biodentine was used as a posterior restoration and revealed satisfactory surface properties such as good marginal adaptation until 6 months and later covered by a surface layer of composite. The statistical results of the study demonstrated lower fracture resistance than the control and experimental groups, but the mean value was at par with the bite force values as demonstrated by Regalo et al. [19]

In the present study, It was believed that the experimental teeth (Group 3) would be more fracture resistant if a strip of 3 mm Everstick fiber was placed against their inner circumference. The idea behind this was that the stress dynamics at the interface between the adhesive glue and the repair would alter if a silanated glass network was present.

The higher modulus of elasticity and lower flexural modulus of the glass fiber might have a modifying effect on how the interfacial stresses are developed along the restoration/tooth

interface. The experimental Group 3 demonstrated fracture resistance which was very close to the control group (intact teeth). The nanohybrid composite material used in the study has been reported to have less polymerization shrinkage, good compressive, and flexure properties.[21] The experimental teeth in Group 4 were restored with FRC as base and covered with 1 mm layer of Z 350 nanocomposite. The mean values of fracture resistance were slightly less than that of control and marginally greater than the Group 3, although statistically there was no significant difference found. The results achieved can be associated with previous studies which concluded that the volume fraction or thickness of short fiber composite could contribute to the crack propagation and load-bearing capacity.[22]

These cutting-edge tools and methods allow the clinician to tackle long-standing issues from a fresh angle, leading to original and creative solutions. Clinicians should continue to base their decisions about how to restore teeth with root fillings on their own clinical experience and patient preferences, even though there is insufficient evidence to support or refute the effectiveness of conventional fillings over crowns. The quantity of tooth that remains is the most crucial factor in restoration selection, since it can affect both cost and long-term survival.[23]

CONCLUSION

Given the negligible variation in fracture resistance values when compared to those of natural teeth, it may be inferred, within the constraints of this in vitro investigation, that both FRC and glass fiber (Everstick,GC) could be taken into consideration as alternatives to crown coverage.

REFERENCES

1. Assif D, Gorfil C. Biomechanical considerations in restoring endodontically treated teeth. J Prosthet Dent 1994;71:565-7.

2. Carter JM, Sorensen SE, Johnson RR, Teitelbaum RL, Levine MS. Punch shear testing of extracted vital and endodontically treated teeth. J Biomech 1983;16:841-8.

3. Sedgley CM, Messer HH. Are endodontically treated teeth more brittle? J Endod 1992;18:332-5.

4. Llena-Puy MC, Forner-Navarro L, Barbero-Navarro I. Vertical root fracture in endodontically treated teeth: A review of 25 cases. Oral Surg Oral Med Oral Pathol Oral Radiol

Endod 2001;92:553-5.

5. Eckerbom M, Magnusson T, Martinsson T. Reasons for and incidence of tooth mortality in a Swedish population. Endod Dent Traumatol 1992;8:230-4.

6. Türp JC, Heydecke G, Krastl G, Pontius O, Antes G, Zitzmann NU. Restoring the fractured root-canal-treated maxillary lateral incisor: In search of an evidence-based approach.

Quintessence Int 2007;38:179-91.

7. Mondelli J, Steagall L, Ishikiriama A, de Lima Navarro MF, Soares FB. Fracture strength of human teeth with cavity preparations. J Prosthet Dent 1980;43:419-22.

8. Panitvisai P, Messer HH. Cuspal deflection in molars in relation to endodontic and restorative procedures. J Endod 1995;21:57-61.

9. Clark D, Khademi J. Modern molar endodontic access and directed dentin conservation. Dent Clin North Am 2010;54:249-73.

10. Smith CT, Schuman N. Restoration of endodontically treated teeth: A guide for the restorative dentist. Quintessence Int 1997;28:457-62.

11. Randow K, Glantz PO. On cantilever loading of vital and non-vital teeth. An experimental clinical study. Acta Odontol Scand 1986;44:271-7.

12. Larson TD, Douglas WH, Geistfeld RE. Effect of prepared cavities on the strength of teeth. Oper Dent 1981;6:2-5.

13. Nagasiri R, Chitmongkolsuk S. Long-term survival of endodontically treated molars without crown coverage: A retrospective cohort study. J Prosthet Dent 2005;93:164-70.

14. Sorensen JA, Martinoff JT. Intracoronal reinforcement and coronal coverage: A study of endodontically treated teeth. J Prosthet Dent 1984;51:780-4.

15. Zelic K, Vukicevic A, Jovicic G, Aleksandrovic S, Filipovic N, Djuric M, et al. Mechanical weakening of devitalized teeth: Three-dimensional finite element analysis and prediction

of tooth fracture. Int Endod J 2015;48:850-63.

16. Chan CP, Lin CP, Tseng SC, Jeng JH. Vertical root fracture in endodontically versus nonendodontically treated teeth: A survey of 315 cases in Chinese patients. Oral Surg Oral

Med Oral Pathol Oral Radiol Endod 1999;87:504-7.

17. Camilleri J. Investigation of Biodentine as dentine replacement material. J Dent 2013;41:600-10.

18. Koubi G, Colon P, Franquin JC, Hartmann A, Richard G, Faure MO, et al. Clinical evaluation of the performance and safety of a new dentine substitute, Biodentine, in the

restoration of posterior teeth – A prospective study. Clin Oral Investig 2013;17:243-9.

19. Regalo SC, Santos CM, Vitti M, Regalo CA, de Vasconcelos PB, Mestriner W Jr., et al. Evaluation of molar and incisor bite force in indigenous compared with white population

in Brazil. Arch Oral Biol 2008;53:282-6.

20. Rudo DN, Karbhari VM. Physical behaviors of fiber reinforcement as applied to tooth stabilization. Dent Clin North Am 1999;43:7-35, v.

21.Availablefrom:http://www.metabiomed.com/eng/cnt/prod/prod020101.html?uid=33&cate ID=2. [Last accessed on 2015 Dec 18].

22. Garoushi S, Säilynoja E, Vallittu PK, Lassila L. Physical properties and depth of cure of a new short fiber reinforced composite. Dent Mater 2013;29:835-41.

23. 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.

Author details:

Vartika Parasrampuria –[1]mds student, Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, UP, India. vats271998@gmail.com 8820408627

Asheesh Sawhny [2]Principal and Head, Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, Uttar Pradesh, India drasheeshmydentist@gmail.com 9838500100

Annu Kushwaha - [3]Reader, Department of conservative Dentistry and Endodontics,

Rama Dental College Hospital and Research Centre, Kanpur, UP, India annusingh144@gmail.com 8400836432.

Prateek Singh- [4]Reader, Department of Conservative Dentistry and Endodontics,

Rama Dental College Hospital and Research Centre,Kanpur, UP, India kushwahaprateek@gmail.com 9721628299

Deeksha Dubey - [5]Senior lecturer ,Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, UP, India

drdeekshadubey@gmail.com 9450206418

Corresponding Author:

Vartika Parasrampuria –[1]Post Graduate student, Department of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre, Kanpur, UP, India. vats271998@gmail.com 8820408627.