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Comparative Evaluation of Core Build-up Materials - Multicore Flow, Zirconomer and Cention-N for Fracture Resistance of Endodontically Treated Teeth: An In Vitro Study

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ABSTRACT

Aim: To compare fracture resistance of endodontically treated premolars restored with MultiCore Flow, Zirconomer, Cention-N and Tetric N-Ceram.

Materials and Methods: Forty freshly extracted premolars were selected and mounted on acrylic cylinders. Mesio-occluso-distal cavities were prepared in all the teeth, and root canal treatment was performed. Then teeth were divided into four groups (n=10) according to the material used for core buildup. Group 1: Tetric N-Ceram, Group 2: Cention-N, Group 3: Zirconomer and Group 4: MultiCore Flow. Then the specimens were mounted on a universal testing machine, and the load was applied until the specimen fractured. The values were tabulated and subjected to statistical analysis.

Results: The mean value of fracture resistance was highest in Group 4, followed by Group 1, Group 2 and Group 3.

Conclusion: MultiCore Flow can be used as the material of choice for restorations in endodontically treated tooth regarding the fracture resistance.

Keywords: Direct core buildup materials, endodontically treated teeth, fracture resistance.

INTRODUCTION

The success of root canal treatment is based upon the conjunction of three-dimensional fluid-tight obturation along with definitive permanent post endodontic restoration to make the pulpless teeth function as an integral part of the dental arch.[1] Ray and Trope observed the absence of periapical inflammation in 91.4% of teeth that had a combination of good endodontic treatments with superior quality post endodontic restorations, whereas poor endodontic treatments with inferior quality post endodontic restorations resulted in the absence of periradicular inflammation in only 18.1% of the teeth. Poor endodontic treatments followed by superior quality permanent post endodontic restorations that appeared radiographically sealed had a success rate of 67.6%.[2]

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Factors attributed for the decrease in fracture resistance of root canal treated teeth are tooth structure loss due to previous restorations or fracture, coronal destruction from dental caries, endodontic access preparations, loss of free unbound water from the lumen and dentinal tubules, age-induced changes in dentin, reduced level of proprioception, the effect of endodontic irrigant and medicament on dentin and effect of bacterial interaction with dentine substrate.[3]

Core buildup materials are used as post endodontic filling materials as they have both structural and functional roles.[4] They usually replace a large bulk of tooth structure; hence their compressive strength and fracture resistance is important and should resist multidirectional masticatory forces.[5]

Amalgam has been the choice of core material because of its strength and dimensional stability.[6] Unfortunately, it lacks adhesion to the tooth structure, which restricts the fracture resistance of the remaining tooth structure due to microcrack propagation receiving fatigue loading.[1] In addition, it also deficits esthetics and biochemical properties. Therefore, a material with more desirable properties is stimulated by trends by the development of enamel-dentin bonding systems and improvements in composites.[5]

Bulk-fill composite resins consume less time with fewer voids and adequate polymerisation as 4 mm thickness increment can be placed in one or two layers and cured. Kumar A et al. stated that filler content plays a significant role in the depth of cure possible with bulk-fill composites. The higher the filler content, the greater the depth of cure, decreases the volume of resin matrix for polymerization, increases hardness and reduce polymerization shrinkage.[7] The use of resin composite has been increased in posterior stress-bearing areas due to better strength and good bonding.[8]

Tetric N-Ceram (TNC) is a conventional nanohybrid bulk fill composite, and it puts forth good physical and esthetic properties engulfing nano-sized filler particles.[9] A new alkaline material, Cention-N offers admirable strength, good aesthetics, fluoride-releasing, is quick and easy to use and also cost-effective.[5]

Modifications in GIC are alternative and substantially accepted core buildup materials and have increased applications in posterior teeth.[5] Incorporating particles of zirconia, Zirconomer (a new generation of GICs) was developed to achieve greater compressive and flexure strengths, less occlusal wear and fast setting reaction.[10]

MultiCore Flow (MCF), a dual-cure composite resin, is a newborn restorative material recommended to be used in high stress-bearing areas. It is a radiopaque composite containing fluoride and inorganic fillers like barium glass, ytterbium trifluoride, Ba-Al-fluorosilicate glass highly dispersed in silicon dioxide.[11]

Sharma A et al. compared fracture resistance of various core buildup materials in endodontically treated premolars and concluded that Cention-N could be used as an alternative to composite resin.[4]

The aim of the study is to compare fracture resistance of endodontically treated premolars restored with MultiCore Flow, Zirconomer, Cention-N and Tetric N-Ceram. The null hypothesis was that there would be no difference between the fracture resistance of core materials.

MATERIAL AND METHOD

Sample selection

Total forty premolar teeth extracted due to orthodontic reasons were selected. Cracks and restorations were checked under x4 magnification using (Labomed Dental Microscope Prima DNT, USA), and ultrasonic scaling was done. Teeth were stored in saline at room temperature. Premolars are more prone to masticatory forces due to their anatomy and location in the dental arch and hence were selected.

To simulate the periodontium, utility wax was liquified at a temperature of 70^{o}C and applied on the roots with a paintbrush up to 2mm below cementoenamel junction until a homogeneous wax thickness of 0.3mm was obtained. The specimens were then embedded in metal matrices containing auto polymerizing acrylic resin (Justis Quick Resin; Ivoclar Vivadent, Schaan, Lichtenstein). All samples were then embedded in an acrylic cube (30 mm external diameter). After curing, the specimens were removed from matrices, and wax was detached from root surface and from the space created in acrylic resin. Later, C-silicon light body impression material was manipulated and inserted into this space. The specimens were repositioned in acrylic resin blocks, and the excess impression material was removed using a scalpel.

Standardized mesio-occluso-distal (MOD) cavities were prepared in all the teeth with no. 245 tungsten-carbide bur (SS White; Dental Health Products, Lakewood, N.J.). The width of the cavity measured with Vernier calliper was kept 1/4th of the intercuspal distance, and the depth of the cavity was kept at 4 mm using a graduated probe. Following MOD cavity preparation, and access cavity with straight buccal and palatal walls was prepared, and deroofing of the pulp chamber was done using an Endo-Z bur(Dentsply, Maillefer, Ballaigeus, Switzerland).

The working length of all the teeth was found between 17 to 21 mm. Canals were prepared using hand K-files (Mani, Inc, Tochigi, Japan) to an apical size 40 with step-back technique, irrigated with 2.5% NaOCl (sodium hypochlorite) followed by 17% EDTA (Prime Dental Products Pvt Ltd, India). Canals were then obturated with gutta-percha (SPI Dental Mfg. Inc., Inchon, Korea) and AH Plus sealer (Dentsply De Trey, Konstanz, Germany) using cold lateral condensation technique.

A Tofflemire® retainer and a matrix band were placed around the tooth to simulate the missing walls, and then teeth were restored according to the groups. Teeth were then randomly divided with ten teeth in each group into the following four groups according to the restoration material:

Group 1: Tetric N-Ceram (control group)

Tetric-N bond Universal (Ivoclar, Vivadent, Liechtenstein, Germany) was applied to the cavity according to manufacturer's instructions and light-cured for 10s, the composite was then placed using bulk fill technique and light-cured for 40 s.

Group 2: Cention-N

The powder and liquid in Cention-N (Ivoclar, Vivadent, Liechtenstein, Germany) was dispensed in a 1:1 ratio and mixed using a plastic spatula. The restoration was placed in the cavity and light-cured for 40 s.

Group 3: Zirconomer

Zirconomer (SHOFU, Japan), hand-mixed at specific powder to liquid ratio of 2:1 using glass slab and plastic spatula. The restoration was placed in the cavity and allowed to sit for 3 mins.

Group 4: MultiCore Flow

Tetric-N bond Universal (Ivoclar, Vivadent, Liechtenstein, Germany) was applied to the cavity according to manufacturer's instructions and light-cured for 10 s. MultiCore Flow was then placed using automix cartridge and light-cured for 40 s. All restorations were polished using SOF-LEX polishing discs (3M ESPE, St. Paul, USA). Teeth were stored in 100% humidity at 37° C for seven days before testing.

Testing conditions

The specimens were mounted and subjected to an axial compressive load applied parallel to the long axis of the tooth and to the slopes of the cusps on a universal testing machine (Instron 3360 Series Universal Testing Systems, UK). A steel sphere loaded perpendicular to the long axis of the tested specimens was 6mm wide at a crosshead speed of 1 mm/min until fracture occurred. The load required for a fracture to occur was expressed in Newton (N) registered by the machine for all four groups of teeth.

The data were analyzed using one-way analysis of variance (ANOVA) and *post hoc* Tukey's test.

RESULTS

Statistics provided the mean fracture resistance values for each group with the value of standard deviation. One-way ANOVA revealed that the highest fracture resistance was seen in MultiCore Flow followed by Zirconomer, Cention-N and least in Tetric N-Ceram. This difference was statistically significant, with $P < 0.05$.[Table 1] [Figure 1]

The *post hoc* Tukey's test revealed significant differences among the groups [Table 2]. There was no statistically significant difference in fracture resistance between Tetric N-Ceram, Cention-N and Zirconomer, whereas MultiCore Flow showed statistically significant results compared to other groups.

Table 1: Comparison of fracture resistance between study groups

Group	N	Mean	Std. Deviation	Std. Error
1	10	265.117000	80.0914934	25.3271540
2	10	311.640000	116.5598114	36.8594488
3	10	381.797000	101.2529831	32.0190046
4	10	578.879000	190.1166811	60.1201733
Total	40	384.358250	173.2856854	27.3988726

Table 2: Inter-group comparison of test results

(I)material code	(J) material code	Mean Difference (I-J)	Std. Error	Sig.
1	2	-46.5230000	57.6182940	.884
	3	-116.6800000	57.6182940	.268
	4	-313.7620000	57.6182940	.000
2	3	-70.1570000	57.6182940	.689
	4	-267.2390000	57.6182940	.001
3	4	-197.0820000	57.6182940	.016

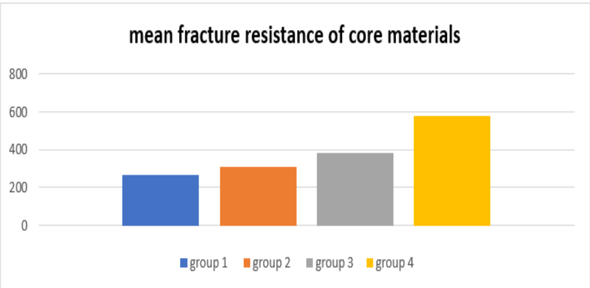

Fig 1: Mean fracture resistance of direct core buildup materials.

DISCUSSION

Endodontically treated teeth have decreased fracture resistance due to loss of tooth structure during access cavity preparation and endodontic radicular procedures. Therefore numerous studies have been conducted to determine the ideal method to restore these teeth.[5,12] Dr Goyal M et al. suggested that an appropriate and prompt permanent restoration after completion of endodontic treatment should be performed.[5]

Vertical fractures might be more prone in endodontically treated teeth compared to healthy teeth [13] because the core strength of the tooth decreases due to the loss of coronal and radicular tooth structure. Some *in vivo* studies presume that endodontic treatment is the foremost cause of tooth fracture.[14-16]

Several factors such as the tooth type, its position in the dental arch, the amount of remaining coronal tooth structure and whether the tooth should serve as an abutment for a fixed or removable partial denture are responsible for the restoration of endodontically treated tooth.[4] Premolars are more liable to masticatory loading and vulnerable to fracture due to their position in the arch and their anatomy with the deep cuspal inclination.[17] To imitate the most common form of tooth loss, MOD cavities were prepared in the premolars leading to root canal therapy.[4]

By the statistical analysis, the null hypothesis was rejected since MCF (578.87 N) showed a significant difference in the fracture resistance of endodontically treated teeth compared to Zirconomer (381.79 N), Cention-N (311.64 N) and TNC (265.11 N). Dr Goyal M et al. revealed that there was no statistically significant difference in fracture resistance of endodontically treated teeth restored with Cention-N (278 N) and composite resin (268 N),[5] which is similar to our study.

TNC has been taken as a control group because the composite resin has been set as the gold standard for core buildup material. It is an excellent treatment option to conserve more tooth structure in root canal filled teeth.[4] Dr Goyal M et al. said that contemporary composite materials used for posterior restorations have high compressive strength, and it has been suggested that due to the adhesive nature of composite, it binds to the cusps, decreases their flexion and reinforces dental stiffness.[5] Furthermore, direct composite resin restoration provides more tooth fracture resistance by providing intra-coronal reinforcement. Fracture within the body, margins of restoration, polymerization shrinkage, technique sensitivity and difficult manipulation are the major drawbacks of composite restorations.[18]

Cention-N has an Isofiller (special patented filler) acting as a shrinkage stress reliever and also minimizing shrinkage like a spring expanding slightly as the forces between the fillers grow during polymerization. In addition, the ratio of organic/inorganic components and the monomer composition of the material is responsible for its low volumetric shrinkage.[19] M Swetha et al. stated Cention-N showed higher fracture resistance compared to composites since it exhibited the highest compressive strength containing organic monomer in the liquid consisting of four different dimethacrylates a combination of UDMA, DCP, PEG-400 DMA, Aromatic Aliphatic UDMA. A major component of the monomer matrix is formed by UDMA. DCP (Tricyclodecan - dimethanoldimethacrylate) having a cyclic aliphatic structure facilitates an increase in strength.[20] Vandhana Sadhananda et al. expressed that the stronger mechanical properties might be credited due to its higher viscosity and deficiency of hydroxyl side groups which are hydrophobic in nature hence demonstrate low water absorption.[21] Scheck L et al. affirmed that Cention-N has a dense polymer network which gives higher strength values.[22]

Zirconomer®, also known as White Amalgam, is developed through a rigorous manufacturing technique to exhibit the strength which is consistent with amalgam. To achieve optimum particle size and characteristics, the glass component of GI undergoes a finely controlled micronization process. Long-lasting durability and high tolerance to occlusal load are reinforced in the material by the homogeneous incorporation of zirconia particles in the glass component. Thus the structural integrity of the restoration is reinforced and is used in posterior load-bearing areas requiring restoration. It is ideal for permanent posterior restorations in patients with high caries incidence and also where strong structural cores and bases are required as it has a combination of magnificent strength and sustained fluoride protection allowing chemical bonding.[23] Kakollu S et al. stated it has the property of transformational toughening, which is the potentiality to prevent the growth of cracks and also affirmed that it has lower fracture resistance as a post endodontic restoration.[24]

MultiCore Flow has high fluoride fillers and low consistency, which permits ease of application. An increase in the filler content expedite higher flexural modulus and consequently increase the fracture resistance of the core material. The strength and longevity of the restoration are reflected by the flexural modulus, which indicates the relative stiffness of the material. To evenly distribute the masticatory forces, the desired modulus of core material should be similar to that of dentin. Moreover, the low consistency of MCF provides higher bond strength with less air contamination.[8] Meredith and colleagues reported that MCF has similar Knoop Hardness Number values to those for dentin which manifests the material more satisfactory for core buildups.[25]

Rai D et al. emphasized that better reinforcing effect in endodontically treated teeth can be provided by MCF and may also result in a better material without deterioration under high stress. Thus it can be used as a direct core build-up material in high-stress bearing areas, replacing the prevailing invasive methods.[11]

A major limitation in our in-vitro study is the single unidirectional load applied by Universal Testing Machine. Masticatory forces having multidirectional characteristics cannot always be truly simulated like that in invivo situation.[26]

CONCLUSION

Within the limitations of this study, it was shown that MultiCore Flow tended to enhance more fracture resistance compared to Zirconomer, Cention-N and TNC as a core buildup material for endodontically treated teeth.

CONFLICTS OF INTEREST

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

REFERENCES

1. 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;12:154-9

2. Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. Int Endo J 1995; 28(1): 12-18.

3. Assif D, Nissan J, Gafni Y, Gordon M. Assessment of the resistance to fracture of endodontically

treated molars restored with amalgam. J Prosthet Dent. 2003 May;89(5): 462-5.

4. Sharma A, Das S, Thomas MS, Ginjupalli K. Evaluation of fracture resistance of endodontically treated premolars restored by alkasite cement compared to various core buildup materials. Saudi Endod J 2019;9:205-9.

5. Dr. Goyal M, Dr. Prasad BSK, Dr. Rao HM. Comparative analysis of four direct post endodontic restorations: A short term study. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) 2019; 18(1): 16-21.

6. Cho GC, Kaneko LM, Donovan TE, White SN. Diametral and compressive strength of dental core materials. J Prosthet Dent. 1999;82(3):272–6.

7. Kumar A, Sarthaj S. In vitro Evaluation of Fracture Resistance of Endodontically treated Teeth restored with Bulk-fill, Bulk-fill Flowable, Fibre-reinforced, and Conventional Resin Composite. JODE 2018; 3(1): 12-17.

8. Panitiwat P, Salimee P. Effect of different composite core materials on fracture resistance of endodontically treated teeth restored with FRC posts. J Appl Oral Sci. 2017;25(2):203-10.

9. Sengun A, Cobankara FK, Orucoglu H. Effect of a new restoration technique on fracture resistance of endodontically treated teeth. Dent Traumatol. 2008 Apr;24(2):214-9.

10. Rawan A, Saroash S. Evaluation of Microleakage in Zirconomer®: A Zirconia Reinforced Glass Ionomer Cement. Acta Stomatol Croat.2018 Jun; 52(2): 97-104.

11. Rai D, Bondarde P, Patil S, Mujawar S, Vishwakarma A, Gakhare R. Comparative Evaluation Of Fracture Resistance Of Endodontically Treated Teeth Restored With Different Core Build-Up Materials: An Invitro Study. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)2018; 17(10): 26-29.

12. Polesel A. Restoration of the endodontically treated posterior tooth. G Ital Endod. 2014;28(1):2–16.

13. Teixeira FB, Teixeira EC, Thompson J, Leinfelder KF, Trope M. Dentinal bonding reaches the root canal system. J EsthetRestor Dent 2004;16:348-54.

14. Gher ME Jr., Dunlap RM, Anderson MH, Kuhl LV. Clinical survey of fractured teeth. J Am Dent Assoc 1987;114:174-7.

15. Lagouvardos P, Sourai P, Douvitsas G. Coronal fractures in posterior teeth. Oper Dent 1989;14:28-32.

16. Pietrokovski J, Lantzman E. Complicated crown fractures in adults. J Prosthet Dent 1973;30:801-7.

17. Eakle WS. Fracture resistance of teeth restored with class II bonded composite resin. J Dent Res 1986;65:149-53.

18. Belli S, Eraslan O, Eskitascioglu G. Direct restoration of endodontically treated teeth: a brief summary of materials and techniques. Curr Oral Heal Reports. 2015;2(4):182–9.

19. Dr.Abrol A, Dr. Aggarwal N, Dr. Gupta P, Dr. Mallika, Dr.Kunjam, Dr.Abrol N. Comparative evaluation of microleakage around class ii cavities restored with zirconomer, tetric n ceram, cention-n and glass ionomer cement-an in vitro study. International Journal Of Current Research 2019; 11 (2): 1641- 44.

20. M Swetha. et al. Comparative evaluation of fracture resistance of silver amalgam, composite and alkasite restorative material- an in vitro study. Acta Scientific Dental Sciences 4.1 2020: 85-90.

21. Vandana Sadananda and Chitharanjan Shetty. Alkasite restorative material: flexural and compressive strength evaluation. 9.5 (2018): 0975-8585.

22. Schenck L et al. A major breakthrough in the field of direct posterior composite resins - thanks to the combined use of Tetric Evo Ceram bulk fill and bluephase style. Special Feature DZW 11 2011: 3-15.

23. Chalissery VP, Marwah N, Almuhaiza M, AlZailai AM, Chalissery EP, Bhandi SH, Anil S. Study of the mechanical properties of the Novel

Zirconia-reinforced Glass Ionomer Cement. J Contemp Dent Pract. 2016 May 1;17(5):394-8.

24. Kakollu S, Thota MM, Yadav BS, Ediga SR, Kalagotla A, Kasireddy J. Evaluation of the fracture resistance of three different core materials used for Nayyar dowel-core technique in restoring endodontically treated teeth: An in vitro study. J Oral Res Rev 2020;12:28-33.

25. Meredith N, Sherriff M, Setchell DJ, Swanson SA. Measurement of the microhardness and Young's modulus of human enamel and dentine using an indentation technique. Arch Oral Biol 1996; 41(6):539-5.

26. Kurthukoti AJ, Paul J, Gandhi K, Rao DB. Fracture resistance of endodontically treated permanent anterior teeth restored with three different esthetic post systems: An in vitro study. J Indian Soc Pedod Prev Dent 2015;33:296-301.