Original Article

Comparative Evaluation of Fracture Resistance of Fiber-Reinforced Composite and Alkasite Restoration in Class I Cavity

G. Rajaraman, AR. Senthil Eagappan[1], S. Bhavani, R. Vijayaraghavan[2], S. Harishma[3], P. Jeyapreetha[4]

Department of Conservative Dentistry and Endodontics, Rajah Muthiah Dental College and Hospital, Annamalai University, Chidambaram, [1]Department of Pedodontics and Preventive Dentistry, Chettinad Dental College and Research Institute, Kelambakkam, [2]Department of Dental Surgery, Government Medical College, Karur, [3]Intern, Department of Conservative Dentistry and Endodontics, Rajah Muthiah Dental College and Hospital, Annamalai University, Chidambaram, [4]Consultant-Oral Pathologist, Le Pearl Dental Clinic, Cuddalore, Tamil Nadu, India

Abstract

Background and Aim: Tooth-colored restorative materials for the restoration of decayed posterior teeth continue to gain popularity both among dental practitioners and patients. These materials have undergone a number of improvements in recent years to enhance their physical properties and diversify their use as a restorative material relevant to clinical practice. The aim of this study was to evaluate and compare the fracture resistance of two such advanced restorative materials, namely EverX Posterior, a fiber-reinforced composite and Cention N, an alkasite material in a Class I Cavity. **Materials and Methods:** Forty intact, caries-free human maxillary premolar teeth extracted for orthodontic purposes were divided randomly into four groups of 10 teeth each. Group I were unprepared teeth (intact teeth); Group II were unrestored teeth with class I cavity; Group III were teeth restored with fiber-reinforced composite (EverX Posterior); and Group IV were teeth restored using alkasite material (Cention N). Fracture resistance was recorded for all samples using a universal testing machine. **Results:** Higher fracture resistance was recorded in intact teeth group followed by EverX Posterior, Cention N and unrestored teeth, respectively. The teeth restored with EverX Posterior showed higher mean fracture resistance to fractures than those restored with Cention N. Teeth restored with EverX Posterior showed no significant difference in mean fracture resistance from Intact teeth while restored teeth with Cention N and unrestored teeth did. **Conclusion:** Fracture resistance of EverX Posterior was comparable to that of the natural tooth and was higher as compared to Cention N.

Keywords: *Alkasite, Cention N, EverX Posterior, Fiber-reinforced composite, fracture resistance*

Introduction

The restoration of the acquired defects due to dental caries should not only aim at achieving functional and esthetic harmony but also provide sufficient strength for the remaining tooth structure. The modern dental practice provides a range of restorative materials from amalgam, glass ionomer cement (GIC), and Light cured resin composites. Due to its unparalleled longevity and strength, amalgam is the most widely used restorative material in posterior teeth. Yet it is gradually being replaced by tooth-colored restorative materials due to its low esthetic and contentious ingredients.[1] Both GIC and Composites are well known to have better esthetics and require limited removal of tooth structure. However, GIC lacks strength and longevity, while the polymerization shrinkage in composites contribute to microleakage which is detrimental to prognosis of the tooth.[2]

Composite resin has undergone numerous developments over the years to enhance its esthetic, physical and mechanical properties.[3] Furthermore, extensive work has been carried out to find alternative material with esthetic, durable, fluoride releasing properties, and better fracture resistance to overcome the restoration fracture, which is the most common cause of restoration failure in posterior teeth.

Short glass fiber-reinforced composite resins have recently been introduced and are intended to be used in stress bearing areas because they exhibits higher load bearing capacity and fracture toughness.[4] EverX Posterior is a fiber-reinforced composite that comprises an combination of e-glass fibers and barium glass fillers inside a polymer matrix and is reported to have higher fracture resistance.[5] Such fibers are reported to be able to monitor polymerization shrinkage and marginal micro-leakage due to their fiber orientation.[6]

How to cite this article: Rajaraman G, Senthil Eagappan AR, Bhavani S, Vijayaraghavan R, Harishma S, Jeyapreetha P. Comparative evaluation of fracture resistance of fiber-reinforced composite and alkasite restoration in class I cavity. Contemp Clin Dent 2022;13:56-60.

Submitted : 07-Aug-2020
Revised : 26-Sep-2020
Accepted : 21-Oct-2020
Published : 23-Mar-2022

Address for correspondence:
Dr. AR. Senthil Eagappan, Department of Pedodontics and Preventive Dentistry, Chettinad Dental College and Research Institute, Kelambakkam - 603 103, Tamil Nadu, India.
E-mail: dr.eaga_ars@yahoo.com

Access this article online

Website: www.contempclindent.org

DOI: 10.4103/ccd.ccd_707_20

Quick Response Code:

Cention N is an alkasite restorative that constitutes a new category of restorative material offering both fluoride release and increased flexural strength. It is a composite resin subgroup and utilizes an alkaline filler, that can release hydroxide ions to regulate the pH value during acid attacks, thus preventing demineralization. It also releases large amounts of fluoride and calcium ions that form a sound basis for remineralization in enamel.[7] Dense polymer networks in the material are responsible for higher strength and is designed for simple and convenient bulk application.[8]

The aim of the present study was to evaluate and compare the fracture resistance of short fiber-reinforced composite (EverX Posterior) and an alkasite material (Cention N) restoration in Class I cavity.

Materials and Methods

A total of 40 sound human maxillary premolars, freshly extracted for orthodontic purposes, were selected. Teeth were cleaned and mounted vertically in acrylic resin blocks. The teeth were embedded in the resin up to 1 mm below the cemento-enamel junction. Ten intact premolars were used as positive control group (Group I) while the remaining 30 premolars received a Class I cavity from a single operator. Standardized Class I cavities were prepared using a tungsten carbide straight fissure bur (FG 172, KERR Haw, Canada) and high-speed water-cooled hand piece (NSK, Japan). The dimensions of the cavity were such that the width of the cavity was one-third of the intercuspal distance and depth of the cavity was 2 mm, which was confirmed using a calibrated periodontal probe [Figure 1]. Used bur was replaced with the new one after every five tooth preparations.

These 30 specimens were then divided into three groups of 10 each. Group II included 10 specimens with standardized Class I cavity preparation, but they remained unrestored and acted as negative controls [Figure 2]. Group III and Group IV are experimental groups, each consisting of 10 specimens with standardized Class I cavity and were restored using EverX Posterior, and Cention N, respectively. The restorative materials used in this study are presented in Table 1.

All the specimens were thermo-cycled for 500 cycles between 5°C and 55°C with 1 min in each cycle. Fracture resistance was tested for all specimens under compression using Universal Testing Machine-Instron. Each specimen was subjected to vertical compressive force with a 3 mm diameter stainless steel ball and a cross head speed of 1 mm/min [Figure 3]. The force necessary to fracture each tooth was recorded and statistically analyzed using ANOVA.

Results

The findings of the present study are shown in Table 2. The highest mean fracture resistance was observed in Group I Intact teeth-Positive control (108.36) followed by Group III EverX Posterior (91.35), Group IV Cention N (73.89) and Group II Unrestored teeth-Negative control (41.36). The graphic representation of the same is shown in Graph 1.

Table 3 shows one-way ANOVA test which revealed a statistically significant difference between the groups ($P < 0.000$). *Post hoc* Tukey test revealed there was no statistically significant difference in mean fracture resistance between Group I Intact teeth-Positive control and Group III EverX Posterior ($P > 0.05$). However, Group I recorded a significant difference with Group IV Cention N at $P < 0.05$ level. Among experimental groups, Group III EverX Posterior had a higher mean fracture resistance when compared to Group IV Cention N. However, it was not statistically significant ($P > 0.05$).

It was also found that there were significant differences in fracture resistance between the prepared, unrestored teeth (Group II) and those restored with EverX Posterior ($P < 0.001$) and Cention N ($P < 0.05$) [Table 4].

Figure 1: Standardized class I cavity preparation. All the cavities presented a depth of 2 mm

Figure 2: Class I cavity prepared and unrestored premolar (Negative controls)

Table 1: Restorative materials used in the study

Product name	Type	Manufacturer	Composition
EverX Posterior	Fiber-reinforced bulk-fill composite	GC Corporation, Tokyo, Japan	Bis-GMA, TEGDMA, PMMA, Barium glass fillers, Short E-glass fibers, 74% by weight of filler load
Cention N	Resin-based bulk-fill alkasite	Ivoclar Vivadent AG, Schaan, Liechtenstein	Powder - Barium aluminum silicate glass filler, Ytterbium trifluoride, Isofiller, Calcium barium aluminum fluorosilicate glass filler and calcium fluorosilicate (alkaline) glass filler Liquid - UDMA, DCP, aromatic aliphatic-UDMA and PEG-400 DMA

Table 2: Mean fracture resistance values and standard deviation of all groups

	n	Mean Kg*f	SD	SE	95% CI for mean		Minimum	Maximum
					Lower bound	Upper bound		
Group I - Intact teeth - Positive Control	10	108.3610	34.74061	10.98595	83.5091	133.2129	71.99	158.50
Group II - Unrestored teeth	10	41.3670	4.98179	1.57538	37.8032	44.9308	35.32	49.45
Group III - EverX Posterior	10	91.3570	31.73189	10.03451	68.6574	114.0566	45.86	121.65
Group IV - Cention N	10	73.8930	22.60951	7.14975	57.7191	90.0669	48.92	113.65

SD: Standard deviation; SE: Standard error; CI: Confidence interval

Table 3: One-way analysis of variance test

	Sum of squares	df	Mean square	*F*	Significant
Between groups	24568.268	3	8189.423	11.913	0.000
Within groups	24748.482	36	687.458		
Total	49316.750	39			

Discussion

Restored teeth are prone to mechanical failures under large stresses and fatigue when compared to healthy teeth.[9] Restorative treatment is a predisposing factor for an incomplete or complete tooth fracture, depending on the extent of the cavity.[10] Contributing factors such as cavity size and design, amount of tooth damage as a result of excavation, and the type of restorative material have been studied over the past few decades.[11]

Posterior teeth have an anatomic shape that makes them particularly the cusps and ridges more prone to fracture due to deflection under occlusal load during mastication. Mechanical and physical properties of restorative materials play a vital role in posterior teeth restorations, as they are subjected to heavy occlusal load.[7] New materials such as fiber-reinforced composites, bulk-fill composites, and composites with higher filler content are developed with better handling properties, decreased polymerization shrinkage, and improved fracture resistance.[12]

The present study was done to evaluate the fracture resistance of EverX Posterior (fiber-reinforced composite) and Cention N, a subgroup of the composite class. Fracture resistance is the inherent property of a material through which it resists deformation under a particular load.[7] The results of the study revealed that intact teeth showed highest mean fracture resistance which is consistent with the studies conducted earlier.[13-15] The highest mean fracture resistance observed in intact teeth could be attributed to no loss of tooth structure.

In this study, there was a significant difference between the mean fracture resistance of intact teeth and teeth that were prepared and unrestored, which is similar to the findings of earlier studies.[16,17] This implies that the fracture resistance of the teeth was reduced after cavity preparation.

In the present study, we found no significant difference in the fracture resistance between teeth restored with EverX Posterior and intact teeth. Fiber-reinforced EverX Posterior is a blend of e-glass fibers and barium glass filler. When impregnated within a composite material, these E-glass fibers are 1–2 mm in length and significantly enhances the mechanical properties.[12] The superior performance of EverX Posterior can be attributed to the composition of this reinforced composite consisting mainly of short e-glass fibers that controls crack propagation through transferring the stress from matrix to fibers. Furthermore, these fibers can control polymerization shrinkage and marginal microleakage because of their orientation.[6]

It was also found that the mean fracture resistance of EverX Posterior was higher as compared with Cention N though the difference was not significant. Thus, the fracture resistance of the two was comparable in the current study. As composites in general are more technique sensitive, and Cention N are easier to manipulate and handle they may be a choice of dental filling for stress bearing posterior teeth.

No studies have been done till date comparing fiber-reinforced composite EverX Posterior with Cention N, and thus, the research findings of the study cannot be substantiated with those of any other studies.

The current study was limited to Class I cavities, which do not involve ridges and thus are less prone to fracture.

Table 4: Multiple comparisons using *post hoc* Tukey test

Reference group	Comparison group	Mean difference (I−J)	SE	Significant	95% CI	
					Lower bound	Upper bound
Group I: Intact Teeth-Positive Control	Group II: Unrestored Teeth	66.99400*	11.72568	0.000	35.4141	98.5739
	Group III: EverX Posterior	17.00400	11.72568	0.477	−14.5759	48.5839
	Group IV: Cention N	34.46800*	11.72568	0.028	2.8881	66.0479
Group II: Unrestored Teeth	Group I: Intact Teeth - Positive Control	−66.99400*	11.72568	0.000	−98.5739	−35.4141
	Group III: EverX Posterior	49.99000*	11.72568	0.001	−81.5699	−18.4101
	Group IV: Cention N	−32.52600*	11.72568	0.041	−64.1059	−.9461
Group III: EverX Posterior	Group I: Intact Teeth - Positive Control	−17.00400	11.72568	0.477	−48.5839	14.5759
	Group II: Unrestored Teeth	49.99000*	11.72568	0.001	18.4101	81.5699
	Group IV: Cention N	17.46400	11.72568	0.454	−14.1159	49.0439
Group IV: Cention N	Group I: Intact Teeth -Positive Control	−34.46800*	11.72568	0.028	−66.0479	−2.8881
	Group II: Unrestored Teeth	32.52600*	11.72568	0.041	0.9461	64.1059
	Group III: EverX Posterior	−17.46400	11.72568	0.454	−49.0439	14.1159

*Mean difference is significant at 0.05 level. CI: Confidence interval; SE: Standard error

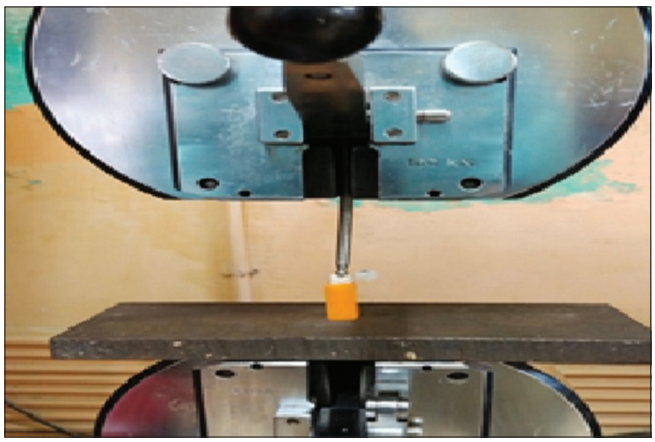
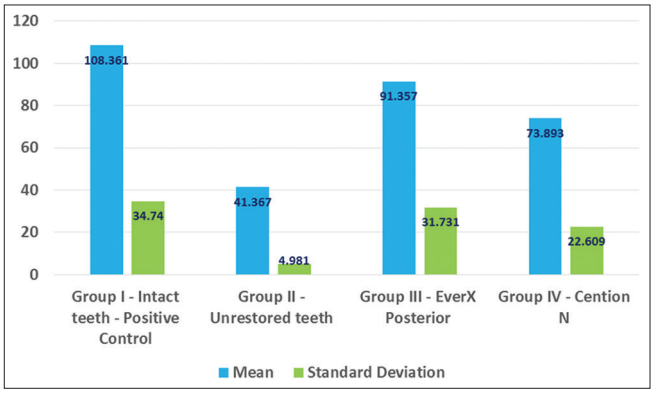


Figure 3: Specimen analysis using universal testing machine (Instron)



Graph 1: Depicting difference in mean fracture resistance between the study groups

Future investigations may focus on comparing material on Class II cavity and as a core build up for endodontically treated molars.

Conclusion

Within the limitations of this study, the mean fracture resistance of EverX Posterior, a fiber-reinforced composite was comparable with that of intact teeth. EverX Posterior demonstrated higher resistance to fracture compared to Cention N. Consequently, EverX Posterior, a fiber-reinforced composite may be preferred for restoring cavities in posterior teeth.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Swetha M, Datta Prasad S, Sunil Kumar C, Vamsee Krishna N, Sunil Kumar S, Chandra Babu KS, *et al*. Comparative evaluation of fracture resistance of silver amalgam, composite and alkasite restorative material – An *in vitro* study". Acta Sci Dent Sci 2020;4:85-90.
2. Mashyakhy M, Jabali A, Karale R, Parthiban G, Sajeev S, Bhandi S. Comparative evaluation of fracture toughness and marginal adaptation of two restorative materials in nonendodontically and endodontically treated teeth: An *in vitro* study. Niger J Clin Pract 2020;23:349-54.
3. Biswas I, Shil R, Mazumdar P, Desai P. Comparative evaluation of fracture resistance of dental amalgam, Dyract-XP composite resin and Cention-N restoration in class I cavity. Int J Innov Res Dent Sci 2018;3:384-92.
4. Garoushi S, Vallittu P, Lassila LV. Fracture toughness, compressive strength and load-bearing capacity of short glass fiber reinforced composite resin. Chin J Dent Res 2011;14:15-9.
5. Shah J, Raghavendra SS. Fracture resistance of a fiber reinforced composite substructure with nanofilled composite overlay. Oral Health Dent 2018;3:567-73.
6. Sah SP, Datta K, Velmurugan N, Lakshmanan G, Karthik L. Evaluation of fracture resistance of endodontically treated maxillary premolars restored with three different core materials: An *in vitro* study. Int J Oral Health Med Res 2018;5:31-7.
7. Chowdhury D, Guha C, Desai P. Comparative evaluation of fracture resistance of dental amalgam, Z350 composite resin and Cention-N restoration in class II cavity. IOSR J Dent Med Sci 2018;17:52-6.

8. Sushma C, Chandrasekhar M, Gopikrishna Reddy M, Nagalakshmi Reddy S, Upendranatha Reddy N, Raghavalli M *et al*. Influence of three different restorative materials on the fracture resistance of endodontically treated tooth. J Evid Based Med Healthc 2020;7:355-9.
9. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: A systematic review of the literature-Part 1. Composition and micro – And macrostructure alterations. Quintessence Int 2007;38:733-43.
10. Hamouda IM, Shehata SH. Fracture resistance of posterior teeth restored with modern restorative materials. J Biomed Res 2011;25:418-24.
11. Yahyazadehfar M, Ivancik J, Majd H, An B, Zhang D, Arola D. On the mechanics of fatigue and fracture in teeth. Appl Mech Rev 2014;66:0308031-03080319.
12. Hada YS, Panwar S. Comparison of the fracture resistance of three different recent composite systems in large Class II mesio-occlusal distal cavities: An *In vitro* study. J Conserv Dent 2019;22:287-91.
13. Kamath U, Salam A. Fracture resistance of maxillary premolars with mod cavities restored with zirconomer: An *in vitro* comparative study. Int J Appl Dent Sci 2016;2:77-80.
14. Kumar A, Sarthaj S. *In vitro* evaluation of fracture resistance of endodontically treated teeth restored with bulk-fill, bulk-fill flowable, fiber-reinforced, and conventional resin composite. J Oper Dent Endod 2018;3:12-7.
15. Santos MJ, Bezzera RB. Fracture resistance of maxillary premolars restored with direct and indirect adhesive techniques. J Can Dent Assoc 2005;71:585.
16. Bassir MM, Labibzadeh A, Mollaverdi F. The effect of amount of lost tooth structure and restorative technique on fracture resistance of endodontically treated premolars. J Conserv Dent 2013;16:413-7.
17. Cobankara FK, Unlu N, Cetin AR, Ozkan HB. The effect of different restoration techniques on the resistance of endodontically-treated molars. Oper Dent 2008;33:526-33.