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

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 exhibit 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]

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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](image1)

![Figure 2: Class I cavity prepared and unrestored premolar (Negative controls)](image2)
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. The results of the study revealed that intact teeth showed highest mean fracture resistance which is consistent with the studies conducted earlier. 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. 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. 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.

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.
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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.

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Nil.

**Conflicts of interest**

There are no conflicts of interest.

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| Reference group       | Comparison group              | Mean difference (I–J) | SE    | Significant | 95% CI          |
|-----------------------|-------------------------------|-----------------------|-------|-------------|-----------------|
| Group I: Intact Teeth-Positive Control | Group II: Unrestored Teeth | 66.99400*            | 11.72568 | 0.000       | 35.4141, 98.5739 |
| Group II: Unrestored Teeth | Group III: EverX Posterior | 17.00400              | 11.72568 | 0.477       | −14.5759, 48.5839 |
| Group III: EverX Posterior | Group IV: Cention N | 34.46800*            | 11.72568 | 0.028       | 2.8881, 66.0479  |
| Group IV: Cention N   | Group I: Intact Teeth - Positive Control | −66.99400*           | 11.72568 | 0.000       | −98.5739, −35.4141 |
| Group I: Intact Teeth | Group III: EverX Posterior | 49.99000*            | 11.72568 | 0.001       | −81.5699, 18.4101 |
| Group III: EverX Posterior | Group IV: Cention N | −32.52600*           | 11.72568 | 0.041       | −74.4159, 8.3839  |
| Group IV: Cention N   | Group I: Intact Teeth - Positive Control | 17.00400              | 11.72568 | 0.477       | −48.5839, 14.5759 |
| Group I: Intact Teeth | Group II: Unrestored Teeth | 49.99000*            | 11.72568 | 0.001       | 18.4101, 81.5699  |
| Group II: Unrestored Teeth | Group III: EverX Posterior | 32.52600*            | 11.72568 | 0.041       | 0.9461, 64.1059   |
| Group III: EverX Posterior | Group IV: Cention N | −17.46400*           | 11.72568 | 0.454       | −49.0439, 14.1159 |

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

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

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