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Comparative Evaluation of the Fracture Resistance of Attached Fragments Using Three Different Materials - An In Vitro Study

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Abstract

Aim of the study: to evaluate and compare the fracture resistance of experimentally fractured human tooth fragments reattached with different adhesive resin materials.

Materials and method: 45 extracted maxillary premolars divided into 3groups were used. After fracturing each tooth, the fragments were reattached with different materials and the force necessary to fracture the teeth was measured.

Results: statistically significant differences werefound between the groups of teeth restored with Superbond as compared with Composite and GIC.

Conclusion: The materials used in this study affected the bond strength of the reattached teeth.

Keywords-traumatic injury, fracture resistance, reattachment, adhesive resins

Introduction

One of the greatest enigma in restorative dentistry is to achieve a bond similar to enamel/dentin or equivalent to tooth structure. Traumatic dental injuries are the most unanticipated events that, if not managed appropriately can have serious consequences for the patient(3).

Regarding the therapy of dental injuries, over the years several methods were attended with varying rates of success and different degrees of complexity. More recently esthetic techniques such as porcelain laminate veneers, porcelain fused to metal crowns and all ceramic crowns have largely replaced the older techniques. Although these more recent techniques deliver a highly esthetic result, they suffer from the disadvantage of jeopardizing the tooth structure and in cases of esthetic emergency their application is not possible(2).

In today’s era of evidence - Reattachment procedures have proven to be a boon for patients with clinical crown fracture due to dento-facial trauma. Reattachment of fragment can provide good and long lasting aesthetics. It is more conservative, simple procedure and also restores tooth function

The aim of this study is to evaluate and compare the fracture resistance of experimentally fractured human tooth fragments reattached with different adhesive resin materials.There are ample of studies conducted on anterior teeth for the management of fracture but limited studies focuses on the posterior teeth. One of the objectives of this study is to evaluate the success of recent restorative materials in reattaching fractured posterior teeth.

Materials and Method

The study was conducted in Department of Conservative Dentistry And Endodontics, Career Post Graduate Institute of Dental Sciences And Hospital, Lucknow UP. Forty-five human permanent Maxillary premolar teeth which were free from cracks or other structural defects were selected for the study. They were disinfected and stored in 0.9% saline solution. Teeth were divided equally and randomly into 3 groups (n=15) based upon the materials used for reattachment of fractured tooth fragments.

Group 1 - Fractured Tooth Fragments Reattached by using Superbond (n=15)

Group 2 - Fractured Tooth Fragments Reattached by using GIC (n=15)

Group 3 - Fractured Tooth Fragments Reattached by using Composite (n=15)

Preparation of Sample

The test basically consisted of three procedures-Splitting of the teeth- the tooth fragments were obtained using hand chisel and mallet, reattachment of fragments with respective materials and fracture of the restored teeth. In group I**,**the fragments were attached by using Super-Bond C&B (Sun Medical Co, Ltd. Moriyama, Japan). The bonding procedure was performed according to the manufacturer’s recommendations. The fractured sur-faces of the fragments were then etched with dentin-etching acid (Super-Bond C&B; Sun Medical Co, Ltd) for 10 seconds and rinsed with distilled water. After slightly drying the surfaces, Super-Bond C&B was mixed using bulk-mix technique (polymer pow-der, 4 drops of monomer and 1 drop of catalyst V) and placed between the fragments (Fig:1).In group 2 fragments were reattached using GIC(Ketac Molar 3M and ESPE)(Fig:2). In Group 3 Both parts of the tooth were etched for 30seconds with 37% orthophosphoric acid, after which they were washed thoroughly for 30-40 seconds and dried gently with a dry cotton pellet. On both dental fragments an abundant amount of adhesive was applied (OptibondSoloPlus, Kerr) which was distempered for 10-15 seconds. Afterwards a thin layer of flow composite(Metafil Flo, Sunmedical) was applied on both dental fragments and finally they were repositioned, with a light digital pressure. Excess material was removed from the buccal and lingualaspect with an applicator. Maintaining the same pressure, each tooth was light cured on both sides for 20-30 seconds(Fig:3).

After reattachment, fracture of the restored teeth was done. The specimens were loaded in the same pre-determined area which was used in procedure, to obtain fragments. The force which was required to detach each fragment was recorded in KgF. The fracture strengths of all sound teeth were averaged. For each tooth, the fracture strength was expressed as a percentage of the load which was required to fracture the sound tooth (strength recovery). This resulted in establishment of a relationship between the fracture strength of an intact tooth and those which were obtained after restoration procedures which were done for all groups. One way ANOVA and Tukey’s test (α = 0.05) were used to evaluate differences among the techniques for each method of obtaining fragment.

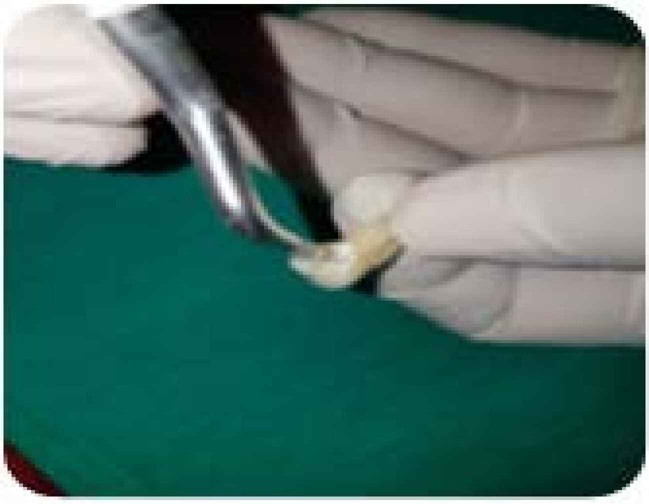

Figure 1

Figure 2

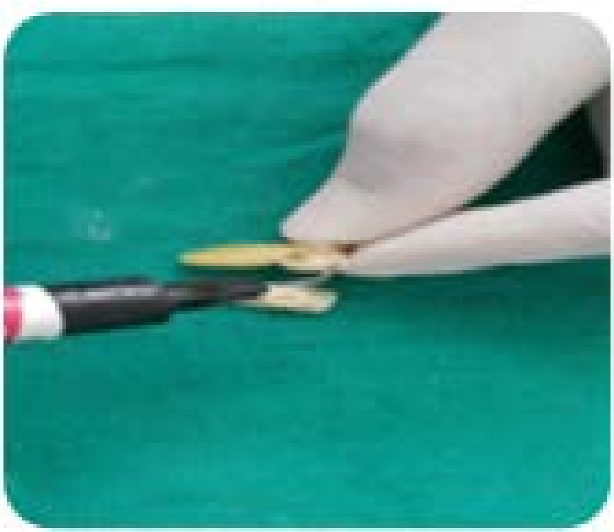

Figure 3

Result

The mean force (Standard deviation) which was required to fracture sound teeth was 22.12 ± 4.1 KgF. The mean fracture resistance (KgF) and standard deviation of sound and restored teeth and the fracture strength recovery (%) of each group was calculated.Group II (GIC) and Group III(COMPOSITE) showed similar fracture strength recoveries($p>0.05$).However, these values were lower than those which were obtained by using Group I (SUPERBOND) Group II(GIC) and Group III (FLOWABLE COMPOSITE) showed fracture strength recoveries of 44.3% and 60.6% respectively. But group I (SUPERBOND) showed excellent fracture strength recoveries of 89.8% .

Groups -reattached	Mean	S.D	%
Group I (SUPERBOND)	19.8	2.2	89.5
Group II (GIC)	9.8	3.7	44.3
Group III (COMPOSITE)	13.4	4.8	60.6

Table: Mean fracture strength (kgf) recovery and standard deviation in experimental groups

Fracture strength recovery was calculated based on the mean and standard deviation of the fracture strength of sound teeth

Discussion

The simple non-penetrating tooth fracture, a common result of sports injuries or accidental trauma, is treated with a restorationof composite material, or if the fractured fragment is kept and not too small, the tooth is recovered by simply repositioning and bonding of the fragment. This second method is very simple and convenient, but it requires high quality adhesive systems and the selection of proper techniques for therespective clinical situation

There are ample of studies conducted on anterior teeth for the management of fracture but limited studies focuses on the posterior teeth. One of the objective of this study was to evaluate the success of recent restorative materials in reattaching fractured posterior teeth

The incidences of dental trauma have increased in number among adolescents.For uncomplicated crown fractures, “Reattachment of fractured tooth fragments” is one of the treatment options.Reis et al., concluded that a simple reattachment with no further preparation of the fragment or tooth could restore only 37.1% of the intact tooth’s fracture resistance[10].Superbond group showed a higher fracture strength recovery than GIC and Composite group.

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Several researchers concluded that flowablecomposite not only reinforced the tooth, but that it also helped inachieving higher bond strength. Because thedehydrated dental surfaces (especially in dentin) may adversely affect theadhesion of the reattached fragments the teeth and dental fragments were keptin a saline solution[2].

The success of the reattachment technique is directly related to the evolution of the adhesive materials, whichcurrently provide a high-quality bond strength between the fragment and the remaining tooth structure. However, the restorative materials should not be selected based exclusively on their mechanical properties, but other properties like biocompatibility and microleakage of the material should be considered for long-term success.[9]

The materials which have been used in literature for reattachment are GIC, resin-modified GIC, totaletch adhesive systems, self-etch adhesive systems, light-, dual-, or self-cured luting cements, as well as conventional or flowable composite Furthermore, composites are the most frequently used material for reattachment of fractured fragments as they provide high bond strength between the reattached fragment and the traumatized tooth, while GICs are one of the groups of adhesive materials that present biological compatibility with the dental tissues. They have fluoride-release capacity and ability to adhere chemically to the dental structures (forms a chelation bond to the actual enamel and dentin surfaces) in a simple and rapid manner. GIC has negligible dimensional changes during the hardening reaction and coefficient of thermal expansion is similar to that of tooth structure. Thus, potential for eventual microleakage is greatly decreased with glass ionomer bonding. Burrow *et al.* have shown that conventional GIC provide significantly lower bond strength as compared to resin-based adhesives and failure mode showed cohesive failure of GIC and mostly adhesive failure for resin-based adhesives.[9]

Conclusion

This in vitro study concluded that Superbond showed excellent performances as compared to the other materials which were tested.Superbond material does not need removal of excess material after reattachment.Whereas in GIC and Composites excess material needs to be carved which may lead to the detachment of the fragment.Hence, reattachment of fractured fragments with SUPERBOND can be a preferred technique .

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