How to Cite:
Dedgaonkar, A. K., Patel, A. R., Jajoo, S. S., Shah, R., Shah, P., & Choudhary, S. (2022). Comparative evaluation of impact strength of natural tooth and two different fragment reattachment technique: An in-vitro study. *International Journal of Health Sciences*, *6*(S10), 1414–1426. https://doi.org/10.53730/ijhs.v6nS10.14030

Comparative evaluation of impact strength of natural tooth and two different fragment reattachment technique: An in-vitro study

Dr. Amruta K. Dedgaonkar
Postgraduate student, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth Dental College and hospital, Pune, India

Dr. Alok R. Patel
HOD & Professor, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth Dental College and hospital, Pune, India

Dr. Shweta S. Jajoo
Assisstant professor, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth Dental College and hospital, Pune, India

Dr. Rohan Shah
Assisstant professor, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth Dental College and hospital, Pune, India

Dr. Preetam Shah
Professor, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth Dental College and hospital, Pune, India

Dr. Shweta Choudhary
Associate Professor, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth Dental College and Hospital, Pune, India

Abstract---Background: The reattached fragments are prone to re-fracture if another traumatic episode occurs or under non-physiological use of the restored teeth. There is a scarcity of literature regarding the management of uncomplicated crown fracture reattachment following a further fracture Therefore, concerns have been directed towards the strength of reattachment of the fractured teeth. Hence the aim of the in-vitro study was to evaluate & compare the impact strength of reattached fragments with composite resin & polyethylene fiber impregnated in composite resin with that of the natural tooth. Methodology: Total samples of 42 teeth were collected and indicated for extraction. They were cleaned ultrasonically and later stored in a 0.9% saline solution. The samples were divided into

three groups of 14 samples each. The fracture was induced by disk, only Ellis class II fractured teeth were included in the study. Group 1 (control group) sound tooth: Directly checked for impact strength. Group 2: Reattachment of the fractured fragment using composite resin. Group 3: Reattachment using polyethylene fiber impregnated in composite resin with minimal preparation. All samples were thermocycled between 5°C - 55°C for 500 cycles with 30 seconds dwell time and tested in an 'impact testing machine'. Result: Highest strength was found in the controlled group(1.26J) followed by group 3(1.07J) and group 2(0.76J). one-way ANOVA test and Post hoc Tukey test indicated statistically significant differences ($p \leq 0.05$), ($p \leq 0.001$) respectively. Conclusion: The impact required to fracture was significantly higher in group 3 which is almost similar to that of the natural tooth and the least was seen in group 2.

Keywords---impact fracture strength, ribbond, fragment reattachment, traumatic dental injuries, composite, polyethylene fiber.

Introduction

"Sometimes your joy is the source of your smile, but sometimes your smile can be the source of your joy." — Thich Nhat Hanh. Smiling gives you an unmatched sense of confidence, spreads joy, and ensures your well-being, along with releasing the happy hormones, commonly known as endorphins. A smile is considered one of your best assets, when coupled with a set of beautifully shaped and aligned teeth, is very esthetic and pleasing. Very often we come across broken, discolored, or missing front teeth, the most common cause being trauma/ accident of some kind. Dental trauma or tooth loss can occur due to diverse etiology, most common include violence, accidents, falls and sport-related activities, with the highest rate of incidence, reported in anterior teeth, representing 18-22% of all dental traumatic injuries, of which 96% involve maxillary central incisors.[1] Epidemiologic studies suggested the prevalence of dental injuries has been reported in a range between 6% and 37%.[2] In a systematic review and meta-analysis conducted in the year 2015 the prevalence of dental trauma in children and adolescents (under 18 years of age) is 17.5%, but with variances among different geographic regions.[2] In both the American and European continents, the prevalence of TDI among teenagers varied from 15% to 23% and 23-35%, respectively, whereas the correspondence prevalence rates in Asia and Africa ranged from 4%-35% and 15-21%.[3]

Trauma to anterior teeth not only affects the child's/adolescent's self-esteem and confidence but has a long-lasting impact on a psychological and social level. The current study was undertaken taken to highlight the impact fracture strength of various techniques used to manage the uncomplicated crown fractures, For uncomplicated crown fractures, the international association of dental traumatology (IADT) guidelines 2020 suggested fragment reattachment as the treatment of choice.[4] Tooth fragment reattachment offers conservative, long-lasting esthetics(as the tooth's original anatomic form, color, and surface texture are maintained), a non-invasive and cost-effective restorative option that is an

acceptable alternative to the restoration of the fractured tooth with resin-based composite or full-coverage crown.[5-8] It can result in a positive psychological response and is a reasonably simple procedure.[9] Additionally, this technique provides a more predictable long-term wear than when the direct composite is used.[10] Several aspects may govern the choice of a fragment reattachment technique. Composite resin was commonly used to restore fractured crowns.[11] However, composite resins have drawbacks such as poor abrasion resistance, the tendency of marginal staining and leakage, discoloration, and lack of marginal integrity.

Ribbond fibers are bondable reinforced fibers made of ultrahigh strength polyethylene strands that were first presented to the market in 1992. These fibers go a long way to exceeding the breaking point of fiberglass and are so resistant that cutting them necessitates the use of special scissors. Ribbond fibers absorb less moisture than dental resins, unlike Kevlar.[12] The reattached fragments are prone to re-fracture if another traumatic episode occurs or under non-physiological use of the restored teeth.[13] Therefore, concerns have been directed towards the strength of reattachment of the fractured teeth. A strong, durable, and predictable union between the fractured fragment and the remaining tooth is the prime determinant. Despite the fact that several research on fragment reattachment is available, there is a scarcity of studies on the management of reattachment of the fractured fragment. hence the aim of this study was to evaluate & compare the impact strength of reattached fragments with composite resin & polyethylene fiber impregnated in composite resin with that of a natural tooth.

Null-hypothesis

Fragment reattachment with composite resin has more impact strength compared to fragments reattached with ribbond fiber and composite resin.

Methodology

Institutional ethics approval was granted before the start of the study EC/NEW/INST/2019/329. The study samples comprised 42 intact freshly extracted human permanent maxillary anterior teeth (Figure 1) which were randomly allocated to three groups using a computer-generated system (Table 1). Experimental groups (groups 2&3) were subjected to sectioning using a diamond disk. The sample preparation was done as described by Santosh Kumar et al the specimen was sectioned at mesio-incisal proximal edge 3mm from the incisal edge in a labio-lingual direction at a 25-degree inclination apically using the diamond disk.[14] (Figure 2 A). Only Ellis class II fractured teeth are included in the study.

- **Group 1** (control group): Sound teeth
  It included intact sound teeth which were not subjected to sectioning and were directly checked for impact fracture strength.
- **Group 2**(experimental group): Reattachment of the fractured fragment using composite resin, where

- The tooth and fragment were etched with 37% orthophosphoric acid (Avnue etch) and bonded together(3M ESPE Adper single bond 2 adhesives).
- Composite resin (3M ESPE Filtek Z350 XT A_2 shade) was incorporated without making any preparation and cured on labial and lingual sides.

- **Group 3**(experimental group): Reattachment of the fractured fragment using polyethylene fiber (Ribbond-2mm of thickness)
  - Measured ribbond fiber was cut. (approximating the mesiodistal length of the tooth)
  - Dentinal groove was prepared on a tooth and fragment of a tooth. (Figure 2 B, C)
  - Etching and bonding of adhering surface were done.
  - Wetting of ribbond fiber was done by a bonding agent, and excess bonding agent was removed by dabbing over a dry paper towel.
  - A thin layer of composite was applied to the tooth and ribbond fiber was placed. (Figure 2 D)
  - The fragment was attached and the entire assembly was cured together of the labial and lingual sides following the manufacturer's instructions.

The teeth (Group 2&3) were finished and polished. Later all the teeth were embedded in auto polymerizing acrylic resin using the customized mold and were stored in sterile water at room temperature for 24 hrs. After 24 hrs., they were thermocycled between 5°C and 55°C for 500 cycles with 30 seconds dwell time. (Figure 3). After finishing thermocycling they were tested in an 'Impact testing machine' (Figure 4) used to measure impact strength.

Results

A total of 42 teeth were included in the study to check for the impact fracture strength. 14 teeth were included in each group (Table 1). The highest impact strength was seen in the control group (1.26J) followed by Composite Resin plus Ribbond Fibre group (1.07J). The composite resin group showed the least impact strength (0.76J), (Figure 5). One-way ANOVA test; * indicates a significant difference at $p \leq 0.05$ (Table 2). Impact strength was significantly higher in control group as compared to composite resin group (Difference: 0.50; p=0.001) & composite resin plus ribbond fibre group (Difference: 0.19; p=0.001) respectively. The impact strength was significantly lesser in the composite resin group as compared to the composite resin plus ribbond fiber group and control group (Difference: 0.31; p=0.001). This difference in impact strength among the three groups was statistically highly significant (p=0.001). Post hoc Tukey test; * indicates a significant difference at $p \leq 0.05$ (Table 3).

Discussion

Managing traumatic injuries effectively has always been a challenge for dentists. To ensure the best outcome, the correct diagnosis, treatment, and follow-up care are required. Traumatized anterior teeth require immediate functional and aesthetic restoration. In this study, two techniques of reattachment namely simple reattachment with composite resin and reattachment with composite resin

with ribbond fiber were analyzed. Due to development in the field of dental adhesives, it is now possible to reattach fractured tooth fragments with excellent results if the biologic factors, materials, and techniques are analyzed and managed logically.[15,16] Thus, in many clinical situations, reattaching a fractured anterior tooth fragment is the best option since it better restores the tooth's natural shape, contour, surface texture, occlusal alignment, and color.[17]

In this study permanent maxillary central incisors were selected for the study as these teeth are more prone to trauma, owing due to their position in the dental arch. The teeth were cut with a diamond disc in a standardized manner. A cut was made in the middle third of the crown so that the tooth fragment could be handled more easily during reattachment and standardization was maintained with an equal amount of area for all the samples. The use of this technique minimized the variation in resistance to fracture resulting from the thickness of the layers of enamel and dentin present, similar findings were noted in a study by Badami et al.[18] The surface created by the cut, on the other hand, had distinct anatomy than the surface created by the fracture caused by trauma to a natural tooth. A smear layer formation was seen as the result of the cut, which was not present on a broken surface otherwise. The orientation of the surface is revealed by cutting governed by the cut direction, but a fractured surface tends to be parallel to the direction of the enamel prisms.[19,20] In this study the orientation of the cut, mimicking the fracture line in a tooth, was dictated by the fact that the cut should establish a repeatable condition necessary for an *in vitro* study.[18] So the sample preparation was done by a single operator to avoid the variation. Additionally, to reduce the selection bias, randomization of the sample before group allocation was done.[21] The operators were blinded all the time for testing the impact fracture strength of the samples and even blinding was also done at the time of statistical analysis.[19]

The most commonly used technique used for reattachment, viz. composite resin, widely used by clinicians was used for reattachment in Group 2. In Group 2 mean value of impact fracture strength was 0.76J which required the least amount of impact fracture strength to fracture the tooth. McDonald's and Avery 1983 demonstrated this technique, where they reattached the fragment to a tooth with minimal or no enamel preparation except acid etching concluding that they showed the least fracture resistance which was in accordance with this study. Similar results were found in studies conducted by authors like Abdulkhayum(2014), and Vamsikrishna (2015),[1,6] probable reasons being smaller bonded area and low thickness of the adhesive and resin cement in the interface because of the perfect fit.

Precision adaptation and good material to unite the two components are crucial needs of the reattachment operation.[22,23] A good dental material for reattachment must have good mechanical qualities to prevent faults from propagating catastrophically under applied stress, as well as good biocompatibility, minimum gingival irritation, and good bond strength. The studies also varied in the method of preparing tooth fragments. Some authors like Farik et al[24-26] Worthington& Munksgaard[27] have sectioned the incisal edge of teeth. Worthington et al.[34] & others have placed small notches on the two proximal surfaces and fractured the teeth by using narrow forceps (Munksgaard et al.,[28

Andreasen et al.[9]) or by using a blunt instrument without making any notches (Dean et al.)[29]

Despite the advancement of these new modern composite materials, their use in clinical conditions involving greater stress is still being debated. Even after reattaching it with composite resin, it did not show enough fracture resistance and the fragment was prone to refracture if another traumatic episode occurred. As a result, there was a scope to develop new techniques which could fulfill the criteria for strength and aesthetics as well. Fiber reinforcement has been proposed to improve the composite's mechanical properties. The kind and length of the fiber, as well as its adhesion to resin and orientation in the matrix, all impact the fiber's reinforcing capacity.[30] Sharafeddin et al. also discovered that the fiber type and composite type have a considerable favorable impact on the FRC's flexural capabilities.[31] In this study Ribbond fiber was used in Group 3. Ribbond has a patented leno weave technology that is used in Ribbond, which contains a lock-stitch feature that successfully transfers forces throughout the weave without stress transfer back into the resin, along with great manageability. Ribbond fits the shape of the teeth and dental arch with almost no memory Ribbond is easy to adapt and manage, when sliced or manipulated it doesn't unravel. Ribbond is multidirectional durable and has sufficient capacity to absorb the impact. Stresses are efficiently transferred throughout the fiber network. Ribbond adheres to any composite material. SEMs show complete resin integration into Ribbond's fibers when magnified 110,000 times (note lack of voids). The Ribbond is an integral strength member of the prosthesis because forces within the resin are easily transferred to the fibers.

The goal of this in vitro study was to find the optimum approach for reattaching damaged anterior teeth in a single visit by restoring their strength the same as that of the natural tooth. Among all experimental groups, maximum impact strength was observed in the control group followed by the group with ribbond fiber with composite resin. The mean Izod impact fracture strength for this group was 1.26 J &1.07 J respectively (Figure 5). which showed impact fracture strength similar to that of the natural tooth. A dentinal groove was prepared to make room for the ribbond fiber and composite resin. Santosh Kumar et al**Error! Bookmark not defined.**[17] performed the study with Simple re-attachment, Over contouring & Internal dentinal groove formation where Sound teeth composed the control group and he found out that the internal dentinal groove produced good fracture resistance compared to all other techniques used.

This increase in the impact strength may be the result of the transfer of stress from the weak polymer matrix to fibers that have a high tensile strength which dissipates the tension lines and prevent the failure of reattachment at masticatory force. Sufyan et al. discovered the highest fracture resistance while utilizing a single fiber in the center slot in a comparable investigation.[32] Although it has been indicated in literature that the larger the fiber bulk, the better the fracture resistance. However, in contrast to the common perception, in a study conducted by Gayatri et al, a single ribbond fiber showed more fracture resistance as compared to two fibers.[33] Also Sharafeddin et al[31] discovered that samples with two fibers in two slots had lower fracture resistance than single fiber samples. Because a centrally located fiber is closer to the long axis of the tooth, it appears

to distribute forces equally across a wider area of the tooth, however, when it is placed farther from the center, the force is dispersed unevenly to other parts. So the use of single ribbond fiber was done in this study and showed a notable result which is almost similar to the impact fracture strength of the natural tooth. Polyethylene ribbond in serving to reinforce the reattachment provides a bridging mechanism. Fracture under the compressive loading thus takes place at the weakest location within the overall system, and not necessarily at the location of the bonded joint. It was assumed that polyethylene fiber had stress modifying effect at the interface of the restoration and dentine. The other feasible confession may be due to the properties of the fiber itself, the degree of chemical bonding between the resin and the fiber, and the effect of the leno weave with regard to crack resistance and deflection as well as resistance to shifting within the resin matrix. The fiber-reinforced composite through the specific orientation of fibers in the fabric and the higher properties within the layer essential act as stitches holding together the joint.[34] Ribbond fiber gives almost original strength to the reattached tooth and fragment, so even if a second traumatic episode occurs the regained impact strength of the reattached tooth could resist the force like that of a natural tooth and will have a high yielding point.

In the late 1960s, temporary and permanent dental restorations of traumatized teeth in young people posed major challenges. Even though there are several methods for restoring fractured teeth, reattachment is considered to be one of the best methods for restoring the teeth's function and aesthetics whenever the fragment is available. Whether or not resin composites are used, reattaching a tooth fragment is the first method recommended to restore fractured teeth today. But some authors have stated the disadvantage of reattachment which includes- Colour change of bonded fragment, fragment allowed to dehydrate, discoloration of auto-curing resin, unknown longevity, the predicted eventual separation Progressive breakdown of the fragment (cyclic fatigue, hydrolytic degradation).[35-38]

Reattachment of the tooth fragments with composite and ribbond fiber can become a more common procedure, because of the excellent strength obtained with the composite resin and ribbond fiber on the etched enamel. This treatment offers several advantages over conventional acid-etch composite restoration namely: minimal tooth preparation, esthetic-color matching of enamel, retention, translucency, the psychological benefit of using one’s own tooth, restores the original function of the tooth, economical, preservation of natural occlusal contact, original morphology is maintained, patient acceptance, a similar rate of occlusal wear as that of original tooth structure, chair-side procedure and less time-consuming.

It acts as a short-medium term restoration with unlimited service potential. It is more economical.[39] The in-vitro nature, variability in the properties of the extracted human permanent incisors and evaluation of the effect of the force in one direction could be the limitation of the present study. However, due to paucity of the studies, this experimental procedure can be regarded as a guide for performing future clinical studies and generating a clinical recommendation for the dentist to treat an uncomplicated crown fracture with a similar situation.

Conclusion

By checking the impact fracture strength, this study concluded that reattachment with ribbond fiber with composite resin showed more impact strength compared to reattachment with composite resin. The re-fracture of the fragment was the concern, where ribbond showed the notable result which can sustain another blow of force with the similar strength of a natural tooth, where earlier the composite restoration used to fracture more often even by normal masticatory forces.

References

1. Abdulkhayum A, Munjal S, Babaji P, Chaurasia VR, Munjal S, Lau H, et al. In-vitro evaluation of fracture strength recovery of reattached anterior fractured tooth fragment using different re-attachment techniques. J Clin Diagn Res JCDR. 2014;8(3):208–11.
2. Azami-Aghdash S, Ebadifard Azar F, Pournaghi Azar F, Rezapour A, Moradi-Joo M, Moosavi A, et al. Prevalence, etiology, and types of dental trauma in children and adolescents: systematic review and meta-analysis. Med J Islam Repub Iran. 2015;29(4):234.
3. Güngör HC. Management of crown-related fractures in children: An update review. Dent Traumatol. 2014;30:88-99.
4. Bourguignon C, Cohenca N, Lauridsen E, Flores MT, O'Connell AC, Day PF, et al International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations. Dent Traumatol. 2020;36:314–30.
5. Andreasen FM, Norén JG, Andreasen JO, Engelhardtsen S, Lindh-Strömberg U. Long-term survival of fragment bonding in the treatment of fractured crowns: a multicenter clinical study. Quintessence Int. 1995;26:669-681.
6. El-Askary FS, Ghalab OH, Eldemerdash FH, Ahmed OI, Fouad SA, Nagy MM. Reattachment of a severely traumatized maxillary central incisor, one-year clinical evaluation: a case report. J Adhes Dent. 2006;8:343-349.
7. Reis A, Loguercio AD, Kraul A, Matson E. Reattachment of fractured teeth: a review of literature regarding techniques and materials. Oper Dent 2004;29:226–233
8. Rappelli G, Massaccesi C, Putignano A. Clinical procedures for the immediate reattachment of a tooth fragment. Dent Traumatol 2002;18(5):281–4.
9. Maia EA, Baratieri LN, de Andrada MA, Monteiro S Jr, de Araújo EM Jr. Tooth fragment reattachment: fundamentals of the technique and two case reports. Quintessence Int. 2003;34(2):99-107.
10. Baratieri LN, Monteiro S Jr., Andrada MAC. Tooth fracture reattachment: case reports. Quintessence Int. 1990;21(4):261–70.
11. Oliveira GM, Ritter AV. Composite resin restorations of permanent incisors with crown fractures. Pediatr Dent. 2009;31(2):102-109.
12. Tuloglu N, Bayrak S, Tunc ES. Different clinical applications of bondable reinforcement ribbond in pediatric dentistry. Eur J Dent. 2009;3(4):329-334.
13. Singhal R, Pathak A. Comparison of the fracture resistance of reattached incisor tooth fragments using 4 different materials. J Indian Soc Pedod Prev Dent. 2012;30(4):310-316.

14. Kumar, S., & Maria, R. Determining the fracture strength of the reattached fragment of anterior teeth: An In Vitro Study. J Dent Allied Sci. 2013;2(1):16-20
15. Olsburgh S, Jacoby T, Krejci I. Crown fractures in the permanent dentition: pulpal and restorative considerations. Dent Traumatol. 2002;18(3):103-115.
16. Farik B, Munksgaard EC, Andreasen JO, Kreiborg S. Fractured teeth bonded with dentin adhesives with and without unfilled resin. Dent Traumatol. 2002;18(2):66-69.
17. Maia EA, Baratieri LN, de Andrada MA, Monteiro S Jr, de Araújo EM Jr. Tooth fragment reattachment: fundamentals of the technique and two case reports. Quintessence Int. 2003;34(2):99-107.
18. Badami AA, Dunne SM, Scheer B. An in vitro investigation into the shear bond strengths of two dentine-bonding agents used in the reattachment of incisal edge fragments. Endod Dent Traumatol. 1995;11(3):129-135.
19. Farik B, Munksgaard EC, Suh BI, Andreasen JO, Kreiborg S. Adhesive bonding of fractured anterior teeth: effect of wet technique and rewetting agent. Am J Dent. 1998;11(6):251-253.
20. Sengun A, Ozer F, Unlu N, Ozturk B. Shear bond strengths of tooth fragments reattached or restored. J Oral Rehabil. 2003;30(1):82-86.
21. Nagendrababu V, Abbott PV, Boutsioukis C, Christos Boutsioukis, Henry F. Duncan, et al. Methodological quality assessment criteria for the evaluation of laboratory-based studies included in systematic reviews within the specialty of Endodontology: A development protocol. Int Endod J. 2022;55(4):326-333.
22. Belcheva A. Reattachment of fractured permanent incisors in school children (review). J IMAB Annual Proceeding (Scientific Papers) 2009;14:96
23. Demarco FF, Fay RM, Pinzon LM, Powers JM. Fracture resistance of re attached coronal fragments – Influence of different adhesive materials and bevel preparation. Dent Traumatol. 2004;20:157-63.
24. Farik B, Munksgaard EC, Kreiborg S, Andreasen JO. Adhesive bonding of fragmented anterior teeth. Endod Dent Traumatol 1998;14:119-23.
25. Farik B, Munksgaard EC, Suh BI, Andreasen JO, Kreiborg S. Adhesive bonding of fractured anterior teeth: Effect of wet technique and rewetting agent. Am J Dent 1998;11:251-253
26. Farik B, Munksgaard EC, Andreasen JO, Kreiborg S. Drying and rewetting anterior crown fragments prior to bonding. Endod Dent Traumatol 1999;15:113-116
27. Farik B, Munksgaard EC. Fracture strength of intact and fragment bonded teeth at various velocities of the applied force. Eur J Oral Sci 1999;107:70-73
28. Munksgaard EC, Højtved L, Jørgensen EH, Andreasen JO, Andreasen FM. Enamel dentin crown fractures bonded with various bonding agents. Endod Dent Traumatol 1991;7:73-77.
29. Dean JA, Avery DR, Swartz ML. Attachment of anterior tooth fragments. Pediatr Dent 1986;8(3):139-143.
30. Lassila LVJ, Tezvergil A, et al. Effects of glass fiber layering on the flexural strength of microfill and hybrid composites. J Esthet Restor Dent 2009;21:171-181.
31. Sharafeddin F, Alavi A, et al. Flexural strength of glass and polyethylene fiber combined with three different composites. J Dent (Shiraz) 2013;14(1):13-19

32. Garoushi SK, Ballo AM, Lassila LV, Vallittu PK. Fracture resistance of fragmented incisal edges restored with fiber-reinforced composite. J Adhes Dent. 2006;8(2):91-95.
33. Galyan G, Padda BK, Kaur TP, Sharma M, Kapur I, Kaur S. In vitro study comparing fracture resistance of nanocomposites with and without fiber reinforcement with different cavity designs used for obliquely fractured incisal edge restoration. J Contemp Dent Pract 2019;20(5):566-570.
34. Belli S, Erdemir A, Yildirim C. Reinforcement effect of polyethylene fibre in root-filled teeth: comparison of two restoration techniques. Int Endod J. 2006;39(2):136-142.
35. Reis A, Francci C, Loguercio AD, Carrilho MR, Rodriques Filho LE. Re-attachment of anterior fractured teeth: fracture strength using different techniques. Oper Dent. 2001;26(3):287-294.
36. Croll TP. Dentin adhesive bonding: new applications (I). Quintessence Int Dent Dig. 1984;15(10):1021-1028.
37. Croll TP. Dentin Adhesive Bonding: New Application (II). Quintessence Int 1984;11:1123-1129.
38. Worthington RB, Murchison F, Kraig VS. Incisal edge reattachment: The effect of preparation utilization and design. Quintessence Int. 1999;30:637-643
39. Rappelli G, Massaccesi C, Putignano A. Clinical procedures for the immediate reattachment of a tooth fragment. Dent Traumatol. 2002;18(5):281-284.

Figure 1. samples used for the study

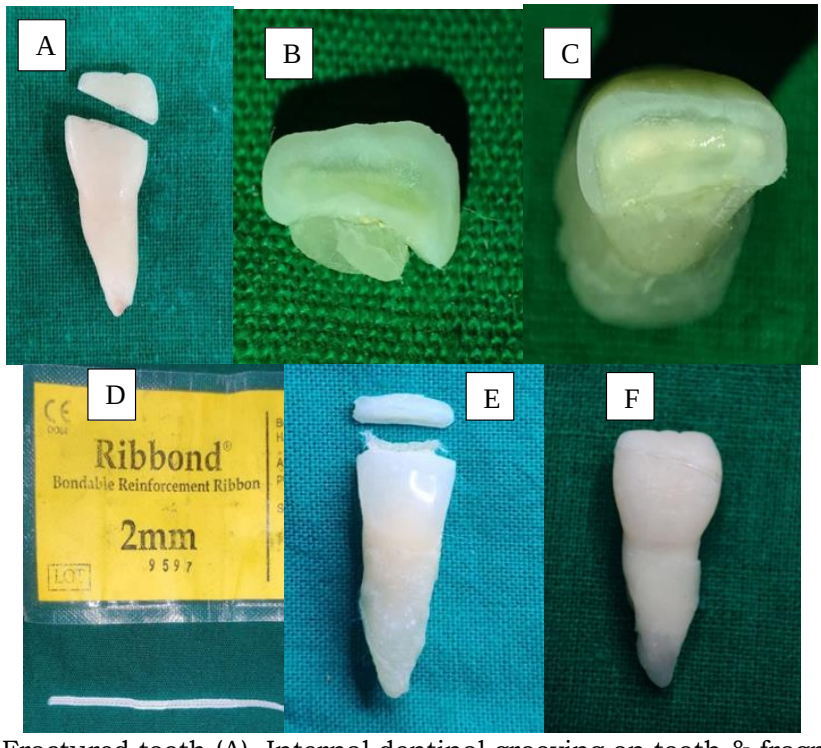

Figure 2. Fractured tooth (A), Internal dentinal grooving on tooth & fragment(B,C), Ribbond fibre (D), Placement of ribbond fibre (E) Reattachment (F)

Figure 3. Thermocycling unit

Figure 4. sample testing for impact fracture strength

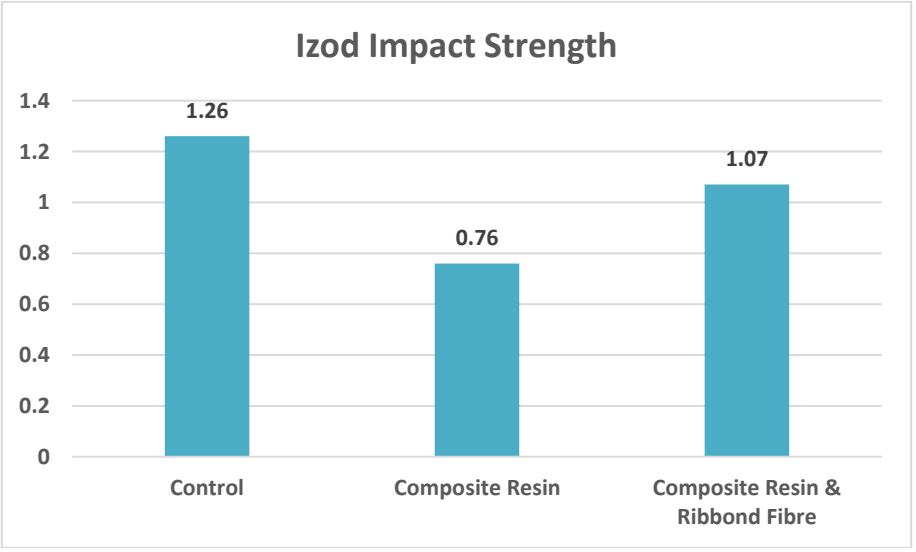

Figure 5. Ditribution of mean Izod impact strength (Joules, J)

Table 1
Distribution of samples among group

	Sample size	Material	Subject to fracture
Group 1 (control)	14	Control	No
Group 2 (experimental)	14	Composite resin	Yes
Group 3 (experimental)	14	Composite resin & ribbond fibre	Yes

Table 2
Comparison of Izod Impact Strength among three groups

One-way ANOVA test; * indicates significant difference at p≤0.05

Groups	Mean	SD	F value	p value
Control	1.26	0.08	152.334	0.001*
Composite Resin	0.76	0.07		
Composite Resin & Ribbond Fibre	1.07	0.08		

Table 3
Pairwise comparison of Izod impact strength

Post hoc tukey test; * indicates significant difference at p≤0.05

Pair	Difference	p value
Control > Composite resin	0.50	0.001*
Control > CR+Ribbond Fibre	0.19	0.001*
CR < CR+Ribbond Fibre	-0.31	0.001*