



## Reattachment of Fractured Anterior Teeth—Determining Fracture Strength using Different Techniques: An *in vitro* Study

Srilatha, Sonal Joshi, Neha Chhasatia, PJ Rani, Ena Mathur

### ABSTRACT

**Aim:** The aim of this *in vitro* study was to evaluate and compare the shear bond strength of teeth reattached with sixth generation dentin bonding agent: Xeno III and microhybrid resin composite: Esthet-X, using three different techniques: (1) Simple reattachment, (2) overcontour and (3) internal dentinal groove.

**Methodology:** A total of 70 human maxillary central incisors were selected and divided into four groups as follows. Group I: Control group comprised of 10 samples. Group II: Simple reattachment, group III: Overcontour and group IV: Internal dentinal groove. Groups II, III and IV comprised of 20 samples each. The teeth in three study groups were sectioned using a diamond disk and the fragment was reattached with Esthet-X and Xeno III using three different techniques. Specimens were stored in tap water for 24 hours and shear bond strength was determined using universal testing machine using a knife-edge chisel (0.5 mm in cross-section) at a crosshead speed of 1 mm/minute.

**Results:** The results of this study showed following mean value of fracture strength in Kgf: Group I: Control—27.71; group II: Simple reattachment—9.78; group III: Overcontour—24.41; group IV: Internal dentinal groove—23.83.

**Conclusion:** The overcontour technique had the highest strength recovery while the simple reattachment had the lowest.

**Clinical significance:** The overcontour technique provided strength recovery almost similar to intact teeth emphasizing that tooth preparation influenced fracture resistance.

**Keywords:** Simple reattachment, Overcontour, Internal dentinal groove, Shear bond strength, Esthet-X, Xeno III.

**How to cite this article:** Srilatha, Joshi S, Chhasatia N, Rani PJ, Mathur E. Reattachment of Fractured Anterior Teeth— Determining Fracture Strength using Different Techniques: An *in vitro* Study. J Contemp Dent Pract 2012; 13(1):61-65.

**Source of support:** Nil

**Conflict of interest:** None declared

### INTRODUCTION

Injury to anterior teeth is a relatively common event that affects children and adolescents due to an increase in dangerous activities and sports.<sup>1</sup> The most affected teeth are upper incisors due to their anterior position and protrusion caused by the eruptive process.<sup>2</sup> Recent investigations into the incidence of dental trauma especially in pediatric and adolescent population have made it clear that this particular injury is of a significant nature and effects up to one-third of patients in this group. Prior studies have reported estimates that about one out of every four persons under the age of 18 will sustain a traumatic dental injury in the form of an anterior crown fracture.<sup>3</sup> These reports confirm that dentists are confronted with managing dental trauma and restoring fractured teeth on a regular basis. Tennery was the first to report the reattachment of a fractured fragment using acid-etch technique. Subsequently, Starkey and Simonsen have reported similar cases.

Several factors influence the management of coronal tooth fractures, including extent of fracture (biological width violation, endodontic involvement, alveolar bone fracture), pattern of fracture and restorability of fractured tooth (associated root fracture), secondary trauma injuries (soft tissue status), presence/absence of fractured tooth fragment and its condition for use (fit between fragment and the remaining tooth structure), occlusion, esthetics, finances and prognosis.<sup>4-6</sup>

Fragment reattachment has been preferred technique among clinicians because it has several advantages over conventional acid-etched composite restorations, such as its a conservative procedure, maintains original tooth contours and translucence, color stability over time, less chairside time, reduces cost of treatment and incisal edge wears at similar rate to adjacent teeth.

Evidence-based literature reviews show that materials do not play a role in fracture strength recovery as it has been shown that internal dentinal groove and overcontouring technique restored with resin composite restoration provided fracture strength as high as ones observed in sound teeth. Accordingly, simple reattachment recovered only 37.1% of intact tooth, buccal chamfer 60.6%, overcontouring 97.2% and internal dentinal groove 90.5%.

## AIM

The aim of this *in vitro* study is to evaluate and compare the shear bond strength of reattached maxillary permanent central incisors using three different techniques: (1) Simple reattachment, (2) overcontouring, (3) internal dentinal groove, restored with microhybrid resin composite: Esthet-X and sixth generation bonding agent: Xeno III.

## METHODOLOGY

This *in vitro* study was conducted in the Department of Conservative Dentistry and Endodontics, KLE'S Institute of Dental Sciences, in association with Department of Civil Engineering, KLE'S Institute of Technology, Belgaum. The main objective was to evaluate and compare the shear bond strength of reattached fractured anterior teeth using three different techniques as follows:

1. Simple reattachment
2. Overcontouring
3. Internal dentinal groove

Restored with one-step adhesive: Xeno III, and micro ( $\mu$ ) hybrid resin composite: Esthet-X, a total of 70 extracted permanent human maxillary central incisors were used for the present study. The test consisted of three procedures:

1. *Sectioning of sound teeth (Fig. 1)*: Experimental specimens were sectioned at the mesial-incisal proximal edge 3 mm from the incisal edge in a labiolingual direction at 25° inclination apically using a diamond disk. Remnants and fragments were matched and stored at room temperatures in tap water for no longer than 48 hours.
2. *Restoration of fractured teeth*: The specimens were divided into four groups with the control group having 10 samples and other three groups having 20 samples each. The groups formed were as follows:
  - *Group I*: Control group—consisted of intact sound teeth which were not subjected to sectioning.
  - *Group II*: Simple reattachment—no additional preparation was made. The sectioned fragments were reattached using one-step adhesive and  $\mu$  hybrid resin composite.

- *Group III*: Overcontouring—following reattachment teeth were prepared on the buccal surface by means of cylindrical diamond finishing bur-extending 2.5 mm coronally and apically from fracture line at a depth of 0.3 mm. Then the areas were treated with one-step adhesive and  $\mu$  hybrid resin composite.
- *Group IV*: Internal dentinal groove of 1 mm deep and wide was placed within the fragment and remaining teeth by means of # 2 round carbide bur with a high-speed hand piece. Then the teeth were restored with one-step adhesive and  $\mu$  hybrid resin composite.

3. *Fracture strength of restored teeth*: The specimens were mounted on custom made fixture for determination of shear bond strength using universal testing machine (Fig. 2). A knife-edge chisel (0.5 mm in cross-section) was used to deliver the force so that contact was achieved 2 mm from the incisal edge. The shearing load was applied at a crosshead speed of 1 mm per minute. The shearing force was noted and shear bond strength was calculated and recorded in kilogram force units (kgf).

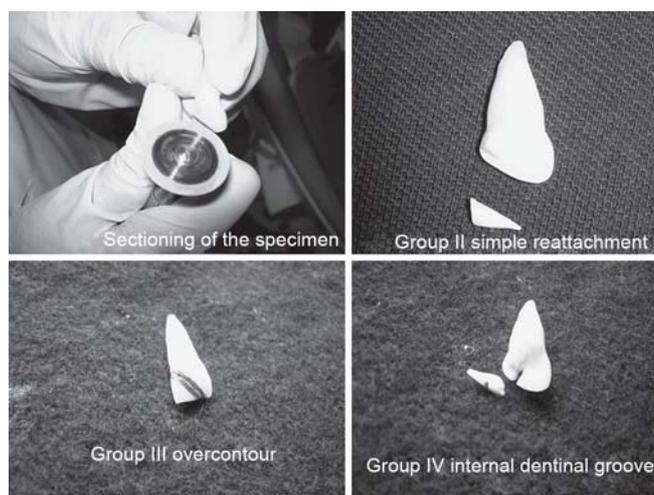


Fig. 1: Sectioning of tooth and preparation

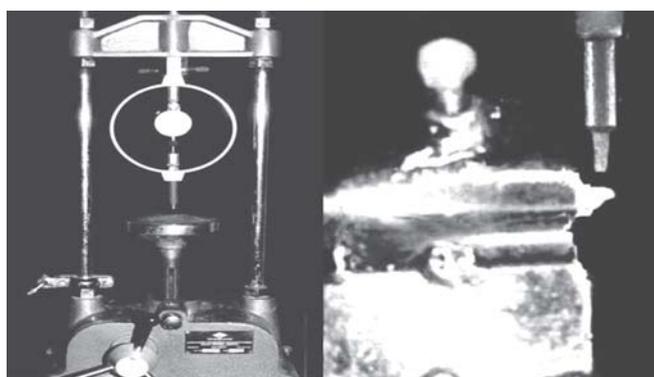


Fig. 2: Universal testing machine with specimen under shearing load

**RESULTS**

A total of 70 extracted permanent human maxillary central incisors that were noncarious, devoid of attrition, abrasion and other structural defects were used for the present study. The undertaking of this study was to determine the fracture strength of reattached fractured anterior teeth using different techniques.

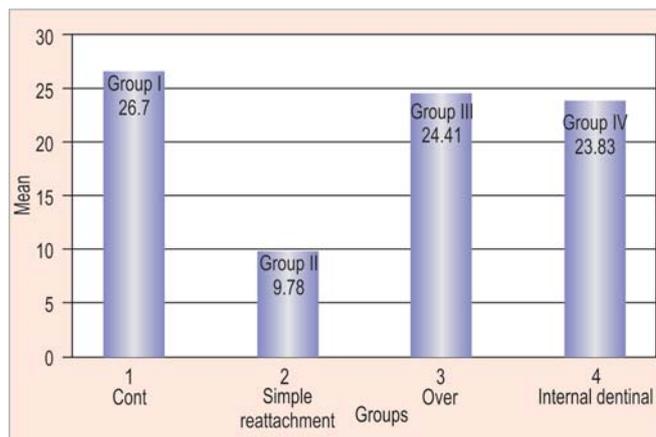
The groups formed were as follows:

- Group I: Control
- Group II: Simple reattachment
- Group III: Overcontouring
- Group IV: Internal dental groove

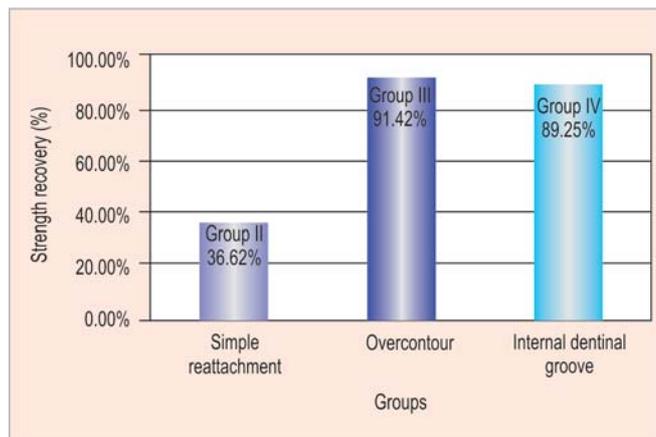
The results of the present study were calculated and mean force and standard deviation required to fracture each study groups are as follows: Group—I  $26.71 \pm 1.40$  kgf; group—II  $9.78 \pm 0.54$ ; group—III  $24.41 \pm 0.81$ ; group—IV,  $23.83 \pm 0.43$  (Table 1 and Graph 1). For each group, the fracture strength was expressed as a percentage (%) of load required to fracture the sound tooth in such a way that it established a relationship between the fracture strength of an intact tooth and fracture strength obtained from restored fractured tooth after it was manipulated by different techniques as described earlier, i.e. simple reattachment, overcontour, internal dental groove. The original strength required to fracture an intact tooth was 26.7 kgf (control group)—the study groups, i.e. groups II, III, IV, after the aforesaid techniques were evaluated in the same manner and then the mean fracture strength (kgf), standard deviation (SD) and strength recovery (%) (Table 2 and Graph 2) of each restored group were noted and presented in Table 3.

The statistical analysis showed the following observation, according to the nonparametric analysis, i.e.

Kruskal-Wallis, revealed  $H = 53.943$ , which invariably gives a total  $p$ -value = 0.002 and, according to parametric analysis, i.e. ANOVA (Dunnett’s test—control vs others), the values revealed  $F = 1804.93$  and  $p = 0.002$ , hence showing a statistical significance of the performed study as per the recorded data. Based on the statistical analysis, the study



**Graph 1:** Mean fracture strength (kgf)



**Graph 2:** Strength recovery of restored teeth (%)

Group I (control)		Group II (simple reattachment)		Group III (overcontour)		Group IV (internal dental groove)	
Mean	SD	Mean	SD	Mean	SD	Mean	SD
26.7 kgf	1.40	9.78 kgf	0.54	24.41 kgf	0.81	23.83 kgf	0.43

Group II (simple reattachment)	Group III (overcontour)	Group IV (internal dental groove)
36.62%	91.42%	89.25%

Group II (simple reattachment)			Group III (overcontour)			Group IV (internal dental groove)		
Mean	SD	(%)	Mean	SD	(%)	Mean	SD	(%)
9.78	0.54	36.62	24.41	0.81	91.42	23.83	0.43	89.25

reveals that when all the study groups, i.e. II, III, IV, compared to the group I, the best technique employed was, the group III: Overcontour, followed by group IV: Internal dentinal groove and the least was the group II: Simple reattachment.

## DISCUSSION

The overall fracture strength recovery (%) in this study was obtained in such a way that it established a relationship between the fracture strength of intact sound teeth and fracture strength of restored teeth, i.e.

- Group II—36.6%
- Group III—91.4%
- Group IV—89.2%

Thus in the present study, group III: Overcontouring had the highest strength recovery followed by group IV: Internal dentinal groove and the least being group II: Simple reattachment.

In overcontouring (group III), good performance could be which attributed to enlargement of adhesion area provided by tooth preparation around the fracture site. The greater extension of material on the surface, the better force distribution over a large enamel area, contrary to what occurred in simple reattachment (group II), where the stress concentration is in the fracture line. However, this greater exposure of resin composite may diminish the long-term esthetics due to process of abrasion and discoloration that occurs due to the composites with time. Polishing at recall appointments may solve this problem.

Placement of internal dentinal groove (group IV) may provide excellent fracture strength and higher esthetic durability almost similar to group III. It is likely that the greater adhesion area and permeability of an internal resin bar which acts as an opponent to the compression load applied on buccal surface could be responsible for the good results obtained in this group.

The simple reattachment (group II) had an overall fracture strength recovery of 36.6%, which indicated that reattachment without preparation exhibited less than 50% of fracture strength displayed by intact teeth.<sup>5</sup>

The results were in agreement where sectioning was employed.<sup>7-9</sup> With fourth generation adhesive: Scotchbond multipurpose and hybrid resin composite: Z-100 and one-step adhesive system: Excite, dual-cure resin cement and resin cement and composite: Tetric Ceram were used. The findings were lower than<sup>2,7</sup> where fragments were obtained by fracturing and one-step adhesive: One step, bisco and dual-cure resin cement was used and four different material combinations along with two different techniques were employed. Group I—one-step adhesive system: Excite (A); group II—A and dual-cure luting cement: Variolink II; group III—A and flowable resin: Tetric flow; Group IV—

A and hybrid resin: Tetric Ceram. These variations may be the reasons for differences in the results.

Fabrication of a mouthguard and patient education about treatment limitations may enhance clinical success as reattachment failures may occur with new trauma or parafunctional habits.<sup>10</sup>

Reattachment of tooth fragment is minimal invasive and esthetic method. The approach is conservative and that is the way with great evidence for reconstruction of crown fractures at school children.<sup>11</sup> Clinical experience and studies indicate that the reattachment of fractured coronal fragments results in successful outcomes that are short and medium term.<sup>12-14</sup>

A study was conducted by Yilmaz et al in 2008 to evaluate clinically and radiographically the restored teeth using reattachment technique of fractured fragment to the remaining tooth with flowable resin composite. The restored teeth were assessed in terms of parental-patient ratings of satisfaction. Both clinically and radiographically, no pathology was reported and all the restorations were successful. Moreover, the mean scores of parental-patient, satisfaction were reported as satisfied, very-satisfied.<sup>15</sup>

The techniques described in this study are reasonably simple, while restoring function and esthetics with a very conservative approach. However, the professional has to keep in mind that a dry and clean working field and the proper use of bonding protocol and materials is the key for achieving success in adhesive dentistry.

However, considering the proposed advantages of these techniques, materials and their widespread use, the majority of these design features are selected empirically and little is known about their influence in long-term success of restorations. Hence, these variables necessitate future critical evaluation.

## CONCLUSION

According to the methodology used within the parameters of this *in vitro* study, the following conclusion can be drawn:

- Fragment reattachment with additional preparation is a realistic alternative for restoring esthetics and function to the traumatized teeth.
- Of the preparations employed in the present study, group III: Overcontouring technique had the highest strength recovery (%) almost similar to the sound intact teeth.
- In contrary, the group II: Simple reattachment without additional preparation has least strength recovery (%).

## REFERENCES

1. Badami AA, Dune 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 dental traumatology 1995;11:129-35.

2. Anthony J Di Angelis, Jungbluth Monica A. Restoration of an amputated crown by acid-etch technique. *Quintessence Int* 1987; 18(12):829-33.
3. Liew VP. Reattachment of original tooth fragment to a fractured crown—case report. *Australian Dental Journal* 1988;33(1): 47-50.
4. Olsburgh S, Jacoby T, Krejci I. Crown fractures in the permanent dentition: Pulpal and restorative considerations. *Dent Traumatol* 2002;18(3):103-15.
5. Reis A, Francci C, Loguercio AD, et al. Reattachment of anterior fractured teeth: Fracture strength using different techniques. *Oper Dent* 2001;26(3):287-94.
6. Andreasen FM, Noren JG, Andreasen JO, et al. Long-term survival of fragment bonding in the treatment of fractured crowns. *Quintessence Int* 1995;26:669-81.
7. Andreasen FM, Steinhædt U, Bille M. Bonding of enamel-dentin crown fragments after crown fracture: An experimental study using bonding agents. *Endodental Traumatology* 1993; 9:111-14.
8. John Kanca III. Replacement of fractured incisor fragment over pulpal exposure: A case report. *Quintessence Int* 1993;24(2): 81-84.
9. Baratieri N, Monteiro S, Mauro Amaral Caldeira de Andrada. Tooth fracture reattachment—case reports. *Quintessence Int* 1990;21(4):261-70.
10. Macedo GA, Diaz PI, Fernandes CA, Ritter AV. Reattachment of anterior teeth fragments: A conservative approach. *J Esthet Restor Dent* 2008;20:5-20.
11. Belcheva A. Reattachment of fractured permanent incisors in schoolchildren (review). *Journal of IMAB. Annual Proceeding (Scientific Papers)* 2008, book 2, 96-99.
12. Rappelli G, Massaccesi C, Putignano A. Clinical procedures for the immediate reattachment of a tooth fragment. *Dent Traumatol* 2002;18(5):281-84.
13. Baratieri LN, Monteiro S Jr, Andrada MAC. Tooth fracture reattachment: Case reports. *Quintessence Int* 1990;21(4):261-70.
14. Oz IA, Haytac MC, Toroglu MS. Multidisciplinary approach to the rehabilitation of a crown-root fracture with original fragment for immediate esthetics: A case report with 4-year follow-up. *Dent Traumatol* 2006;22(1):48-52.
15. Yilmaz Y, Zehir C, Eyuboglu O, Belduz N. Evaluation of success in the reattachment of coronal fractures. *Dental Traumatology* 2008;24(2):151-58.

## ABOUT THE AUTHORS

### Srilatha (Corresponding Author)

Senior Lecturer, Department of Conservative Dentistry and Endodontics BVDU Dental College and Hospital, Pune, Maharashtra, India  
e-mail: drsri2005@yahoo.com

### Sonal Joshi

Professor and Head, Department of Conservative Dentistry and Endodontics, KLE College and Dental Sciences, Belgaum, Karnataka India

### Neha Chhasatia

Reader, Department of Conservative Dentistry and Endodontics Manubhai Patel Dental College and Hospital, Vadodara, Gujarat, India

### PJ Rani

Professor, Department of Oral Medicine and Radiology, SGT Dental College, Gurgaon, Haryana, India

### Ena Mathur

Senior Lecturer, Department of Oral Medicine and Radiology Mahatma Gandhi Dental College and Hospital, Jaipur, Rajasthan India