Original Research

Comparative Evaluation of Impact Strength of Fragment Bonded Teeth and Intact Teeth: An *In Vitro* Study

L Venugopal[1], M Narasimha Lakshmi[2], Devatha Ashok Babu[3], V Ravi Kiran[4]

Contributors:
[1]Professor, Department of Dentistry, Rajiv Gandhi Institute of Medical Sciences, Srikakulam, Andhra Pradesh; India; [2]Assistant Professor, Department of Orthodontics, Government Dental College, Hyderabad, Andhra Pradesh, India; [3]Reader, Department of Orthodontics, Gitam Dental College, Visakhapatnam, Andhra Pradesh, India; [4]Professor, Department of Prosthodontics, Siddhartha Institute of Dental Sciences, Gannavaram, Vijayawada, Andhra Pradesh, India.
Correspondence:
Dr. Venugopal L. Department of Dentistry, Rajiv Gandhi Institute of Medical Sciences, Srikakulam, Andhra Pradesh, India. Email: Lagishettyvenugopal@gmail.com

How to cite the article:
Venugopal L, Lakshmi MN, Babu DA, Kiran VR. Comparative evaluation of impact strength of fragment bonded teeth and intact teeth: An *in vitro* study. J Int Oral Health 2014;6(3):73-6.

Abstract:
Background: To test and compare the impact strength of fragment bonded teeth with that of intact teeth by using impact testing machine (pendulum type) as a mode of load.
Materials and Methods: Forty extracted, maxillary, central incisors selected for this study (20 control group and 20 experimental group). In experimental group, teeth crowns were fractured with a microtome at 2.5 mm from mesioincisal angle cervically, fractured portion is attached to original crown portion with 3 M single bond dentin bonding agent and 3 M Z '100', composite resin. Impact strength of fragment bonded teeth and intact teeth tested with impact testing machine and compared.
Results: Mean impact strength of fragment bonded teeth (30.76 KJ/M²) is not statistically significant deferent from mean impact strength of intact teeth (31.11 KJ/M²).
Conclusion: Mean impact strength of fragment bonded teeth is not statistically different with that of intact teeth. Hence, after fracture of teeth if it is restored with fragment reattachment by using 3 M single bond dentin bonding agent and 3 M Z '100' composite resin is having impact strength like that of intact teeth.

Key Words: Composite resins, dentin bonding, impact strength, reattachment, teeth fracture

Introduction
Trauma to the oral cavity may involve soft tissues such as lips, cheeks, tongue, floor of the mouth and hard tissues such as teeth, jaws, and temporomandibular joint.[1-3]

Most dental injuries occur during the first two decades of life with boys and girls ratio 2:1 to 3:1.[4-6] Most commonly affected teeth are maxillary incisors. Crown fractures involving enamel or enamel and dentin without pulp involvement is the most common type of fracture.[3,7]

After fracture if fractured fragment is attached to original crown segment has advantages like provides a very esthetic result, long lasting esthetics improved functions positive social and emotional response from the patient.[6] In this study, the fractured fragment bonded with 3 M single bond dentin bonding agent and 3 M Z '100' composite resin restorative.

The objective of the study is to test and compare the impact strength of fragment bonded teeth with that of intact teeth by using impact testing machine (pendulum type) as a mode of load.[8]

Materials and Methods
This *in vitro* study is conducted to compare the impact strength of fragment bonded teeth (which is bonded with 3 M single bond dentin bonding agent and 3 M Z '100' composite resin) with that of intact teeth.

Materials and instrument used in this study
1) 3 M single bond dentin bonding agent
2) 3 M Z '100' composite resin restorative
3) 3 M etchant
4) 40 extracted maxillary incisors
5) Normal saline
6) Cold cure acrylic resin, powder, and liquid
7) Stone plaster
8) Cylindrical iron ring (8 cm Inner diameter, 2.6 cm height, cylindrical iron rod, 2.6 cm height, 2.6 cm diameter)
9) Hard tissue micro tome
10) Impact testing machine
11) Bard Parker handle no. 15 blade
12) Composite polishing kit
13) Airotor handpiece
14) Finishing bur
15) Micromotor contra angle handpiece and straight handpiece
16) Plastic filling instrument
17) Light cure unit
18) 2 brushes
19) Divider
20) Scale
21) Wax sheets
22) Dappen dish
23) Diamond disk

24) Ceramic tile
25) Hand scaler
26) Vaseline.

Methodology

Selection of samples

A total of 40 maxillary incisors are collected; calculus and soft tissue deposits are removed with hand scaler and stored in normal saline until use. These 40 samples were divided in two groups Group I, i.e. intact teeth and Group II, i.e. fractured fragment bonded teeth each containing 20 samples (Table 1).

Preparation of stone plaster mold

A cylindrical shaped stone plaster mound of 8 cm diameter; 2.6 cm height, with 2.6 cm diameter round shaped hole in the center is prepared.

A cylindrical shaped iron ring with 8 cm inner diameter and 2.6 cm height is used to prepare the stone plaster mold Vaseline applied to the inner surface of the ring by brush and kept on the ceramic tile. Stone plaster (w:p ratio 0.28) is mixed according to the manufacturer's directions and poured into the iron ring then an iron rod after applying Vaseline which is of 2.6 cm diameter, 2.6 cm height is introduced into the center of the poured stone plaster to the bottom of the rod then stone plaster mold is removed from iron by slowly rotating the iron ring. (setting time of stone plaster - 30 to 60 min.)

Preparation of acrylic resin blocks and embedding of teeth

After preparation of stone plaster mold a cylindrical acrylic block of 2.5 cm diameter and 2.5 cm height with embedded samples are prepared.

Vaseline applied with a brush to the central hole of the stone plaster mold. Then stone plaster mold is kept on the ceramic tile. Cold cure acrylic rein (p:l ratio according to manufacturer's direction) poured into the central hole by sprinkle on the method from bottom to the top. Before acrylic resin sets Group I of samples were embedded in such way that only 2.5 mm of the crown portion is exposed from mesioincisal angle cervically in the same way Group II samples were prepared instead of 2.5 mm of crown length exposed, full crown length exposed.

Then both Groups I and II samples (cylindric acrylic resin blocks with embedded samples) were removed from stone plaster mold before acrylic resin initial setting occurred by applying pressure to the bottom of the samples. After removing the samples that is cylindric acrylic resin blocks with 2.6 cm diameter 2.6 cm height with teeth embedded is finished and polished in such a way that cyclindric acrylic resin blocks with 2.5 cm diameter, 2.5 cm height with teeth embedded in the center are obtained.

Table 1: Preparation of samples for embedding in the impact testing machine and measuring the impact strength.	
Groups	**Samples**
Group I (control group)	20 maxillary incisors which were embedded in acrylic resin with 2.5 mm crown exposure from mesioincisal angle cervically (intact Teeth)
Group II (experimental group)	20 maxillary incisors in which crown portion was fractured at a distance of 2.5 mm from mesioincisal angle cervically with microtome and attached with 3 M single bond dentin bonding agent and 3 M Z '100' composite resin restorative

Preparation of Group II samples (fracturing and attaching of samples)

Group-II samples in which full crowns were exposed, crown portion fractured with microstone transversely to the long axis of the tooth, parallel to the incisal edge at a distance 2.5 mm cervically from mesioncisal angle the fractured fragment is attached to the remaining intact crown portion with 3 m single bond dentin bonding agent the fractured piece and remaining intact crown portion are attached at fractured surface with 37% phosphoric acid for 15 s rinsed for 5 s with water and later air dried. Two coats of 3 m single bond dentine bonding agent applied on fractured surface of fractured piece and remaining intact crown fractured surface with a brush and light cured for 10 s. A thin film of 3 M Z '100' composite rein restorative applied on fractured surface of fractured piece and remaining intact crown fractured surface with plastic filling instrument and were properly aligned and light cured for 60 s from labial and lingual surfaces. Excess composite resin is removed with scalpel, final polishing is done with disks.

Wax sheet is adapted to Group II samples around the top of the periphery of the acrylic resin cylindrical in such a way that only fractured and attached portion is exposed i.e. 2.5 mm from the mesioncisal angle cervically. Then cold cure acrylic resin is mixed in a dappenish according to the manufacturer's directions and poured into wax adapted samples.

In Groups I and II samples (acrylic resin cylinders with 2.5 mm of the crown portion exposed) acrylic resin removed from bottoms upwards with diamond disc in micromotor contra angle and straight handpiece except 7.5 mm nearer crown portion in such a way that with this reduction a square shaped acrylic resin has remained with the measurement of 1 cm^2 in the center of the acrylic resin cylinder. Then at the bottom of the acrylic resin square shape in such way that acrylic resin and wax from top to bottom will become 5 cm. Then cold cure acrylic resin is mixed in dappendish according to manufacturer's directions and poured into this square shaped wax Sheet. Now whole acrylic resin becomes 5 cm from top to bottom then samples embedded in impact testing machine in such a way that the tooth axis is perpendicular to the 3.5 Kg/7.5 mm^2 pendulum of the testing device. The speed of the pendulum is 2.39 m/s when it hits the samples. The impact pendulum hits the crown portion at a distance of 2.5 mm in the mesial

aspect from mesioincisal angle cervically. The impact strength recorded in joules per square millimeter area. Now this impact strength value converted into kilo joules per square meter area. Results compared with Student's *t*-test.

Results

Grouping of samples

Comparison of impact strength of intact teeth and bonded teeth was carried out by Student's *t*-test, *t* = 1.4, which is not significant with a *P* = 0.16. This shows impact strength of bonded teeth is statically not significant with that of intact teeth.

Discussion

Maxillary incisors are selected in this study because maxillary incisors are more prone to fracture.[3,9]

Most commonly observed dental fracture involves enamel and dentin without pulp involvement, they accounts for $1/3^{rd}$ of all dental injuries.[3,10,11] So in the present study, maxillary incisors with dental fractures selected, after fracturing they are united to the original crown segment with 3 M single Bond dentin bonding agent and 3 M Z '100' composite resin restorative.

Main objective of this study is to test and compare the impact strength of fragment bonded teeth with that of intact teeth (natural teeth).[8,12,13]

In the present study, the fragment was reunited to the original crown segment immediately after fracture.

Both two groups of samples (Experimental and Control Groups) are embedded in impact testing machine for measuring impact strength, impact strength is recorded in KJ/m^2 area by hitting the samples with impact testing machine pendulum at 2.5 mm from mesioincisal angle cervically in the mesial aspect.

Mean impact strength of intact teeth is 31.11 KJ/m^2, standard deviation 0.92, standard error 0.20 mean impact strength of bonded teeth is 30.76 KJ/m^2, standard deviation 0.66, standard error 0.14 (Table 2).

Mean impact strength of bonded teeth is not significantly different from the mean impact strength of intact teeth of with *t* value 1.4 and *P* value 0.16 (significant, if *P* < 0.05).

The results observed in this study are in agreement with the results obtained from the previous studies done by Farik B. Munksgaard E.C. (Fracture strength of intact and fragment bonded teeth at various velocities of applied force. Eur Journal Oforal Sciences 1999:10:70-73).[14]

Conclusion

This study concluded that mean impact strength of intact teeth is 31.11 KJ/m^2, mean impact strength of fragment bonded

Table 2: Statistical analysis of data.				
Group	Count	Mean	Standard deviation	Standard error
Group I (intact Teeth)	20	31.11	0.92	0.20
Group II (bonded Teeth)	20	30.76	0.66	0.14

t value=1.4, *P* value=0.16 (significant, if *P*<0.05)
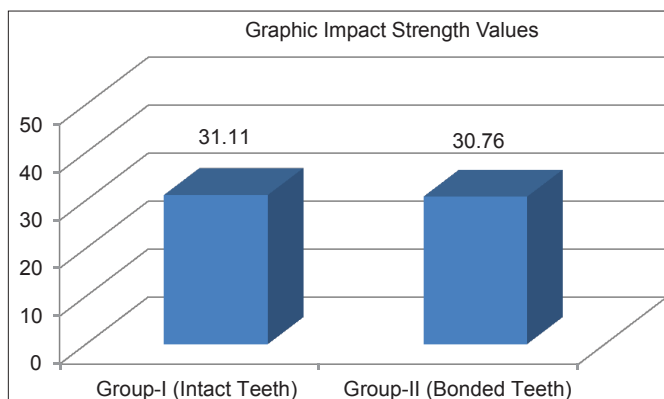

Figure 1: Statistical analysis of data.

teeth) is 30.76 KJ/M^2. Mean impact strength of fragment bonded teeth is not statistically different with that of intact teeth (Figure 1), so after fracture of teeth, if it is restored with fragment reattachment by using 3 M single bond dentin bonding agent and 3 M Z '100' composite resin restorative is having impact strength like that of intact teeth. Further clinical studies are in progress to establish half-life of such restoration.

Clinical Significance

In clinical situation, the most common dental trauma involves maxillary central incisors with dentinal fractures. After fracture, of teeth with fractured fragment is available if it is reattached to original crown portion provides very esthetic result. Long lasting esthetics, positive social, and emotional response from the patient. Hence, we have to encourage reattachment in the clinical situation.

References

1. Mader C. Restoration of fractured anbterio tooth. J Am Dent Assoc 1978;96(1):113-5.
2. Cunha RF, Pugliesi DM, de Mello Vieira AE. Oral trauma in Brazilian patients aged 0-3 years. Dent Traumatol 2001;17(5):210-2.
3. Ingle J, Bakland LK. Endodontics 4th ed. This Text Book which has been known as the bible of endodontics for over 40 Years with 88 contributing authors from all over the world 1994.
4. Hall DA. Restoration of a shattered tooth. J Am Dent Assoc 1998;129(1):105-6.
5. Grossman LI. Received Doctorate in Dental surgery at university of Pennsylvania in 1923 & Doctorate in Medical Denstistry at the university of Rostock in Germany in 1928, Endodontic Practice, 12th ed. 2010.
6. Baratieri LN, Monteiro S Jr, Caldeira de Andrada MA.

Tooth fracture reattachment: Case reports. Quintessence Int 1990;21(4);261-70.

7. DeSchepper EJ. Compomers, reattachment method expandrestoration capabilities. J Indiana Dent Assoc 1998;77(4):42-5.

8. Farik B, Munksgaard EC, Andreasen JO. Impact strength of teeth restored by fragment –bonding. Endod Dent Traumatol 2000;16(4):151-3.

9. DiAngelis AJ, Jugbluth MA. Restoration of an amputated crown by the acid-etch technique. Quintessence Int 1987;18(12):829-33.

10. Baratieri LN, Ritter AV, Monteiro Junior S, de Mello Filho JC. Tooth fragment reattachment: An alternative forrestoration of fractured anterior. Pract Periodontics Aesthet Dent 1998;10(1):115-25.

11. Farik B, Munksgaard EC, Andreasen JO, Kreiborg S. Drying and rewetting anterior crown fragments prior to bonding. Endod Dent Traumatol 1999;15(3):358-6.

12. Burke FJ, Repair of Fractured incisors using a 4 –META luting material. Dent Update 1997;24(9);358-60.

13. Caldas AF Jr, Burgos ME. A retrospective study of traumatic dental injuries in a Brazilian dental trauma clinic. Dent Traumatol 2001;17(6):250-3.

14. Farik B, Munksgaard EC. Fracture strength of intact and fragment-bonded teeth at various velocities of the appliedforce. Eur J Oral Sci 1999;107(1):70-3.