A Comparative Evaluation of the Fracture Strength of Pulpotomized Primary Molars Restored with Various Restorative Materials

Sidhi Passi* / I.K. Pandit** / Nikhil Srivastava*** / Neeraj Gugnani**** / Monika Gupta*****

Sixty extracted primary molars were used in the study. After pulpotomy, these were divided into four groups on the basis of restorative materials to be used. Results showed that the Ormocer had the maximum fracture strength while the posterior Glass Ionomer Cement showed the least fracture strength among the various restorative materials used in the study

Key words: *Pulpotomy, restoration, ormocer, glass ionomer*
J Clin Pediatr Dent 31(3):164-166, 2007

INTRODUCTION

Pulpotomies are indicated for pulp exposures in primary teeth when the inflammation or infection is judged to be confined to the coronal pulp.[4] The pulpotomy procedure has to be followed by the placement of a restoration. Till date stainless steel crowns and amalgam restoration have been the restorations of choice for the pulpotomized primary teeth.[6,16]

Stainless steel crowns have some disadvantages that require preparation of sound tooth structure not directly involved in the decay process and provide no esthetic solution to the clinical problem. The use of amalgam for the pulpotomized tooth also has the disadvantage that it does not bond to the tooth structure and does not reinforce or strengthen the remaining tooth structure in a significantly compromised tooth for example pulpotomized molars. Moreover, both these materials are unesthetic.[13]

Today, every focus is diverted to conserve tooth structure using restorative materials which adhere to the tooth by minimal intervention and are tooth colored to provide esthetics. Unnecessary loss of tooth structure leads to increased brittleness of the pulpally treated tooth, so increased fracture toughness of these dental materials is essential. Increased focus on the esthetic and preservation of tooth structure has led to the development of bonded restorations like Giomer, Ormocer etc. It was the objective of this study to evaluate, therefore, the cuspal fracture resistance of pulpotomized primary molars restored with different adhesive systems..

From the Dept of Pedodontics and Preventive Dentistry, D.A.V. (C) Dental College & Hospital

* Dr. Sidhi Passi, Post Graduate Student
**Dr. I.K. Pandit, M.D.S., F.P.F.A., Principal & Head of Department
***Dr. Nikhil Srivastava, M.D.S., Professor
****Dr. Neeraj Gugnani, M.D.S., Associate Professor
*****Dr. Monika Gupta, Senior Lecturer

All correspondence should be sent to: Dr. I.K. Pandit, Principal, Professor & Head of Department, Dept. of Pedodontics & Preventive Dentistry, D.A.V. (C) Dental College & Hospital, Yamuna Nagar, HARYANA -135001 (India).

tel: 09416050402 (Mobile)
01732-220804 (O)

MATERIALS AND METHODS

60 primary molar teeth indicated for extraction were collected for the present study. Only teeth with at least one half of the root length remaining were selected for the study. Standard pulpotomy cavities were prepared, teeth were air dried and the canal orifices were capped with a layer of hard setting zinc oxide eugenol. A lining of fast setting $Ca(OH)_2$ was placed over it and the walls were cleaned of any calcium hydroxide, using a sharp small excavator. Teeth were randomly divided into four groups of 15 teeth each and the restorative materials were placed in the prepared cavity as follows:

Group A: (Posterior radio-opaque Glass Ionomer Cement) Powder and liquid was mixed on mixing pad in ratio (3.1: 1) for 25-30 sec. with plastic spatula. Mixture was inserted into the prepared cavity. After that GC Fuji varnish was applied on entire surface.

Group B: (Giomer) The prepared pulpotomy cavity was treated with a mixture of FB primer A and B for 10 sec. Excess primer was removed with gentle air drying, then the low viscosity FB bond was placed and light cured for 10 sec. and the cavity was restored with resin composite (Beautiful) and light cured for 40 sec.

Group C: (Ormocer) The prepared pulpotomy cavity was treated with 37% phosphoric acid (Voco cid, voco) for fifteen seconds, rinsed with water for twenty seconds, dried optimally with blotting paper to remove excess water leaving a moist surface.

Bonding agent was applied (according to manufacturer's instructions) for 30 seconds and light cured for 20 seconds.

Composite resin (Ormocer) was placed in the prepared cavity and light cured for 40-60 seconds.

Group D: (Amalgam) Triturated amalgam was condensed into the prepared pulpotomy cavity after squeezing of the excess mercury. The restoration was then carved to reproduce the proper tooth anatomy and then was burnished to smoothen the rough margin and surface of the restoration.

The samples were placed in the rectangular aluminum molds con-

taining a thin mix of acrylic resin in such a way that the facial and the lingual cusps of the teeth were in the same plane. The acrylic resin was placed up to 1-2mm of the tooth surface below cemento enamel junction to approximate the height of healthy alveolar bone. The mounted samples were stored in artificial saliva at room temperature before being subjected to thermocycling. The teeth were subjected to 1000 thermocycles between 50-550C with a dwell time of 30 seconds at each temperatures. All the samples were then subjected to fracture strength test using universal testing machine (Inströn, Lloyd, LR 100, U.K.). Different sized tapered steel cones with diameter of 3.5mm for primary first molars, 4.5mm for lower primary second molars and 5.5mm for primary upper second molars were used. The teeth were tested to compression at a speed of 5.0 mm/min and the breaking load was measured by recording the reading on the display panel of the machine.

The data collected was tabulated accordingly and was subjected to statistical analysis.

RESULTS

Posterior Glass Ionomer Cement (Fuji IX GP) showed the least fracture strength among the materials tested while Ormocer showed the maximum fracture strength.

A highly significant difference ($P<0.05$) was observed in the fracture strength of Posterior Glass Ionomer Cement with the other materials tested. Amalgam showed significant difference in fracture strength values when compared with Giomer and Ormocer and significant difference was also found in the fracture strength values between Giomer and Ormocer (Table 1 - 3).

Ormocer showed maximum fracture strength while the Posterior Glass Ionomer Cement showed the least fracture strength.

Table 1: Mean fracture strength and standard deviation in different study groups.

Group	No. of samples	Mean Fracture strength (N)	Upper Value	Lower Value	Standard Deviation
Group A	15	525.6	675.00	407.00	97.8416
Group B	15	1034	1325.00	865.00	156.7209
Group C	15	1235	1487.00	931.00	201.9915
Group D	15	671.60	857.00	403.00	132.8510

Table 2: Analysis of varience (ANOVA) for fracture strength of different restorative materials used in the study.

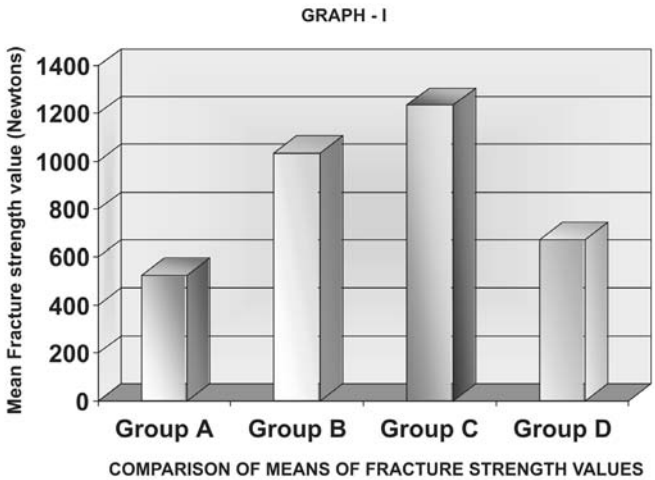
Source of Variation	Degree of freedom	Sum of Squares	Mean sum of squares	Variance ratio 'F' Value	'P' value
Between group	3	4770708.00	1590236.00	68.70541	0.000001**
Within Group	56	1296160.00	23145.720		
Total	59	6066868.00			

**Highly Significant

Table 3: Comparison of means of fracture strength values between different groips using Student T Test.

Group	't' value	'P' value
A versus B	10.657	0.0001**
A versus C	12.252	0.0001**
A versus D	3.427	0.001905**
B versus C	3.045	0.005024*
B versus D	6.832	0.0001*
C versus D	9.025	0.0001*

*Significant **Highly Significant



Graph 1: Comparison of means of fracture strength values of different restorative materials used in the study.

Graph (1)

It shows the comparisons of means of fracture strength values of different restorative materials used in the study. A significant difference was observed in the fracture strength of the various restorative materials used ($p<0.05$).

DISCUSSION

Dental caries has been and still continues to be among the most commonly occurring dental disease in the world.[18] The increasing craze for junk food and modern food habits among the youngsters has further increased their susceptibility to caries. Thus, it should receive a significant attention as far as its prevention is concerned.[18] But today's fast life and negligence by parents on account of excuse of lack of time and low socio-economic status presents an obstacle in assess of children to these preventive measures. Parents usually approach the dentist when the caries has progressed far beyond the dentinoenamel junction and is near the pulp or has already resulted in the pulpal exposure, indicating the various endodontic procedures like pulpotomy or pulpectomy.

Unnecessary loss of tooth structure leads to increased brittleness of the pulpally treated tooth, so increased fracture toughness of these materials is necessary. Fracture toughness or the clinical stress intensity, is a mechanical property that describes the resistance of the brittle material to the catastrophic propagation of the flaws under

applied stress.[1]

Increased focus on esthetics and preservation of the tooth structure has led to the development of bonded restorations like Giomer, Ormocer, Resin modified Glass Ionomer Cement. Bonded restorations preserve the tooth structure and enhance the fracture toughness of the tooth. They also maintain normal contact area, avoid gingival trauma during crown placement and provide an esthetic restoration.[13] El - Kalla and Garcia-Godoy demonstrated that the bonded resin based materials increased the fracture resistance of primary teeth restored after pulpotomies.[17]

The posterior Glass Ionomer Cement has been developed with some additional benefits to the patient, especially children, it may provide better esthetics, stronger bond and long term results, largely due to the small mean particle size which increase the viscosity of the material.[2] Castro and Reigal[2] gave promising results for this material.

Giomer is a hybrid esthetic restorative material which employs the use of pre-reacted Glass Ionomer (PRG) technology. The fluoro-alumino-silicate glass in these materials is reacted with polyalkenoic acid in water prior to inclusion into silica filled urethane resin.[21] Giomer bond is Glass Ionomer base, tricurable, all-in-one, filled adhesive based on PRG technology and consists of 4-AET, 4-AETA, UDMA, HEMA, PRG filler, fluoroaluminosilicate glass, acetone, water and initiator. Due to inclusion of these filler, Giomer possibly showed higher fracture strength as compared to Glass Ionomer Cement and amalgam.

Ormocer stands for organically modified ceramic. It is a three dimensionally cross-linked copolymer. Ormocers are advanced filling materials for use in dentistry which, due to their innovative matrix technology and filler particles represent state-of-the-art sciene.[20]

The clinical success of the newer restorative materials depends upon a good adhesion (good bonding) with the dentinal surface to resist various dislodging forces acting within the oral cavity. Hence, the aim of the presently selected study was to determine and compare the fracture strength of different restorative materials.

Intergroup Comparison: There was highly significant difference in fracture strength of Glass Ionomer Cement with all other groups as shown by student 't' test, when Amalgam was compared with Giomer and Ormocer there was significant difference in mean fracture strength value ('p' < 0.05).

Thus, Ormocer restorative material showed maximum mean fracture strength due to the presence of Ormocer moieties, which help to strengthen the resin and composite assembly bonded to dentin via hybrid layer formation.[20] Posterior Glass Ionomer Cement showed minimum mean fracture strength value amongst all the groups, this might be due to the reason that this material rely on the chemical bond to the tooth rather than mechanical bond, which is a weak bond.[19]

Hurmuzlu *et al*[12] showed that the fracture resistance of Ormocer and Packable composites was higher than amalgam, which was in accordance with the results obtained by fracture strength testing.

Several newer materials are being launched constantly in the market, with laboratory data showing superiority of these materials over the others. So, clinician lands in a perplexing condition in choosing the better materials. So, both in vitro and in vivo clinical studies should be undertaken so as to provide clinician a valid data base and help him to choose the material with confidence.

CONCLUSIONS

Since bonded restorations not only provide esthetic but also have adequate fracture toughness, they can be used as an alternative to the amalgam and stainless steel crown for restoring the endodontically treated primary molars. In the present study, Posterior Glass Ionomer Cement showed the least fracture strength among the materials tested while Ormocer showed the maximum fracture strength. Highly significant difference ($P<0.05$) was observed in the fracture strength of various restorative materials used.

REFERENCES

1. Anusavice KJ. Phillip's science of dental materials. 11th edition. 2003. Saunder's; 49-74.
2. Castro A, Feigal RF. Microleakage of new improved Glass Ionomer restorative material in primary and permanent teeth. Pediat Dent. 24:23-28, 2002.
3. Castro AKP. Thermal and mechanical load cycling on microleakage and shear bond strength to the dentin. J Oper Dent 29 (1) : 42-48, 2004.
4. Cohen Stephen, Burns C Richard. Pathways of the pulp. 8th edition, 2002, Mosby Publications; 685-718.
5. Cotert H.S. In vitro comparison of cuspal fracture resistance of posteri or teeth restored with various adhesive restorations. Int J Prosthodont 14 (4):374-378, 2001.
6. Davina A.B. A conservative approach to the primary teeth. J. Clinic Ped Dent Winter 22 : 103 -105, 1998
7. Elkins CJ, McCourt JW. Bond strength of dentinal adhesives in primary teeth. Quintessence Int. 24: 271 - 273, 1993.
8. Gale MS, Darwell B. Thermal cycling procedures for the laboratory testing of dental restoration. J Dentistry 27:89-99, 1999.
9. Gao W, Peng D, Smales RJ, Yip KH. Comparison of atraumatic restorative treatment and conventional restorative procedures in a hospital clinic: evaluation after 30 months. Quintessence Int. 34(1):31-37, 2003.
10. Gorucu J, Ozgunaltay G. Fracture resistance of Class II bonded Amalgam and new tooth colored materials. J Oper Dent 28 (5):501-507, 2003.
11. Gotti G, Goracci C, Godoy FG, Ferrari M. Evaluation of the bonding mechanism of an adhesive material to primary teeth. J Dent Child. 71: 54 - 60, 2004.
12. Hurmuzlu F, Kirenitci A, Altundasa E, Hergumer S. Fracture resistance of endodontically treated premolars restored with Ormocer and Packable Composites. J Endodontics 29(12):838 - 840, 2003.
13. El-Kalla IH, Garcia-Godoy F Fracture strength of Adhesively Restored pulpotomized Primary Molars. J Dent Child 66 : 238 - 242, July - Aug 1999.
14. Ingle JJ, Bakland LK. A textbook of Endodontics. Fifth Edition 2002. Mosby Publications; 861-902.
15. Kevin James Donly. Cuspal reinforcement in Primary teeth: an invitro comparison of the restorative materials. American Academy of Pediatric Dentistry10 (2):103-104, 1988.
16. Kilpatrick NM. Durability of Restorations in primary molars. J Dent 21:67-73, 1993.
17. Guelmann M, Kelsey LB, Villata P,Garcia Godoy F. Microleakage of Restorative Techniques for pulpotomized primary Molars. J Dent Child 71 (3): 209 -211, 2004.
18. Mc Donald RE, Avery DR. Dentistry for the Child and Adolescent. 8th Edition, 2004. Mosby Publications; 390 - 412.
19. Miyazaki M, Iwasaka K, Soyamura T, Onose H, Moore BK. Resin modified glass ionomers : Dentin Bond strength versus time. Oper Dent 23: 144 -144, 1998.
20. Product Information Guide : Admira bond / Admira; Voco, Germany.
21. Product Information Guide: Beautiful, Shofu, Japan.