

COMPARISON OF THE FRACTURE RESISTANCE OF REATTACHED TOOTH FRAGMENT VERSUS COMPOSITE CORE BUILD-UP USING THREE DIFFERENT POST SYSTEMS IN ENDODONTICALLY TREATED ANTERIORS – AN IN VITRO STUDY.

Dr. Thendral S¹, Dr. Rajesh Gopal V², Dr. Benin Paulaian³, Dr. Sudharsana S⁴, Dr. Jaikolden K⁵

^{1,2,3,4,5}Department of Conservative Dentistry and Endodontics, Rajas Dental College and Hospital, Tirunelveli, Tamil Nadu

Article Info: Received 04 April 2020; Accepted 20 May 2020

DOI: <https://doi.org/10.32553/ijmbs.v4i5.1147>

Corresponding author: Dr. Thendral S

Conflict of interest: No conflict of interest.

Abstract

Objective: To compare the fracture resistance of endodontically treated teeth restored with Parapost, Everstick and Ribbond post systems.

Materials and Methods: Root canal therapy was performed in 40 maxillary anteriors. The coronal portion of the teeth were sectioned at the junction of coronal and middle third of the crown and they were divided into four groups [n=10]. Group I served as a positive control. In group II, III and IV Parapost, Everstick and Ribbond were used respectively to restore the tooth. In group II the sectioned coronal fragment was reattached and in group III and IV core build up was done using composite. Specimens were loaded until failure in a universal testing machine and the resistance to fracture was calculated.

Statistical Analysis: Datas were analysed using One Way ANOVA and Dunnett test.

Results: Mean fracture resistance was as follows: Control – 393.0 N, Parapost – 238.0 N, Ribbond – 134.0 N, Everstick – 222N. The fracture strength of Parapost with reattached fracture fragment showed statistically significant fracture strength values when compared with Ribbond and Everstick where composite was used as a core build up material

Keywords: Fracture resistance, Reattachment, Everstick, Ribbond, Parapost

Introduction

The current conservative Endodontic techniques have increased the efficacy by which the endodontically treated teeth are being restored¹. Agglomeration of research studies were carried out in the past where the loss of water, tropocollagen's ultrastructure, architectural modification and loss of proprioception of endodontically treated teeth were studied and the results obtained were in contrary.^{2,3,4,5,6} Following these studies, later Assif reported that endodontically treated teeth have not altered with regard to their modulus of elasticity, their hardness or fracture resistance. He also stated that more the tooth structure is lost, higher the risk of fracture⁷. Consequently, in order to protect the endodontically treated teeth, that became fragile due to dental structure loss, the deflection capacity must be prevented by either fixing it with a prosthetic coverage or reinforcing its walls with an adhesive material which will reduce the flexion of the tooth.

When maxillary anteriors were considered in this regard, the incidence of traumatic injuries in the anteriors were reported to be 20 to 30% world-wide⁸. The management of these traumatized teeth is often aimed at endodontically treating the teeth and reinforcing the root with fibre-reinforced post systems followed by restoring the lost

coronal tooth structure either by reattaching the coronal tooth fragment or by using conventional composite core build-up. In this view, the anterior teeth restoration has a significant impact on esthetics and social well-being of the subject.

Some researchers have stressed the requirements of using posts made with biomechanical properties similar to the hard tissues of the tooth. Till recent times, older post systems consisted of metal alloys that resulted in final heterogenous combination of dentin, metallic post system and core material. Some researchers have stressed the requirements of using post made with biomechanical properties similar to the hard tissues of the tooth^{9,10}. Assif and Gorfil stated that when root canals were restored with intra-radicular posts and cores, stress concentration occurred at the coronal third of the root and most commonly at the interface of material with different elastic moduli⁷. So the prime objective is to restore the teeth with physico-chemically homogenous materials that have properties similar to dentin¹¹. Christel *et al* initially evaluated zirconia posts that exhibited high flexural strength and resistance to fracture¹². Recently, fibre – reinforced composite posts have been introduced as an alternative to metallic posts. These fibre posts are usually luted with adhesive resin cement, due to their low elasticity, cement acts as a shock absorber and decreases

the risk of root fracture. This material has shown better survival rates over long follow-up periods^{13, 14}.

Studies have evaluated the resistance to fracture of the endodontically treated teeth restored with different pre-fabricated fibre post systems and obtained varied results^{15, 16, 17}. The available clinical evidence also shows the superior performance of the fibre posts and their protective role against restorative failures in conditions of coronal destruction and lower incidence of root fractures¹⁸. Apart from these clinical investigations, literature possess a lacunae in comparing the fracture resistance of reattached coronal tooth fragment with different fibre-reinforced post systems.

So, the aim of the present study is to compare the fracture resistance of endodontically treated teeth restored with different fibre reinforced posts namely Parapost, Everstick fibre post and Ribbond fibre followed by either reattached fragment or composite core build up.

Materials and Methods:

Forty freshly extracted maxillary central incisors free of cracks, caries, and fractures were selected for the study. All external debris was removed with an ultrasonic scaler, and the teeth were stored in saline solution. The anatomic crowns of 30 teeth were sectioned perpendicular to the long axis, at the junction of cervical one-third and incisal two-third of the crown with a diamond disc [Kerr, United states] using a micro-motor hand-piece at a speed of 25,000 rpm with water cooling. Out of 40 samples 10 unsectioned samples served as the control. All the root canals of the sectioned samples were chemo mechanically prepared with stainless steel hand files [MANI, Inc.]. Apical enlargement was done till 45k ISO sized file followed by further step back preparation until size 80. The irrigation during instrumentation was done with 3% sodium hypochlorite [Prime Dental, India] and the final irrigation was done with distilled water for standardization. Canals were dried with paper points [DiaDent, US] and coated with a Calcium Hydroxide based endodontic sealer [Seal apex, Kerr Dental]. Master cone of size 45 was selected and checked for its fit into the root canal until the working length. The master gutta-percha point was coated with the same sealer [Seal apex, Kerr Dental] and seated in the canal to the full working length. A finger spreader (MANI, Inc.,) was inserted into the canal to a level approximately 1 mm short of the working length followed by lateral compaction with Gutta-percha cones [Dia Dent, US] until the root canal was completely filled and gutta-percha was sheared off by the Beefill system's plugger [VDW, Germany] and down – packing was done to obturate the apical 5mm of the root canal space thus achieving an apical sectional obturation. Following this the samples were assigned into groups 2,3 and 4 with 10 samples per group.

In group 2, where Parapost [Parapost Fibre White, Coltene Whaledent] was used, post space preparation was done with the respective Parapost drills until 1.5mm in diameter to cement the respective sized post. The Paraposts were cemented with self-etch, self-adhesive resin cement [Max Cem Elite, Kerr Ltd]. The adhesive resin cement was mixed for 10 seconds and applied in the canal walls. A thin layer of cement also was placed on the post surface, and the post was inserted into the canal. Excess cement was removed, and the remainder was light-polymerized for 40 seconds. Following this, the sectioned coronal fragments were reattached. A vent was created in the lingual surface of the fragment so that the Parapost could be inserted through the vent and the fragment was etched with 37% Phosphoric acid and rinsed followed by drying and application of a single coat of bonding agent [Tetric-N-Bond, Ivoclar Vivadent] and light cured for 45 seconds. This fragment was reattached with the respective samples through the vent created for the Parapost to be inserted by using flowable nanohybrid composite [Tetric-N-Ceram, Ivoclar, Vivadent].

In group 3, where Everstick [GC, Europe] and group 4, Ribbond [Ribbond Inc., Seattle, WA, USA] was used, post space preparation was done with paeso reamers size 2 and fibres of size 1.5mm were selected and required length was cut from the silicone strip using scissors. The canal was filled with Stick resin [Everstick GC, Europe] with an intra-oral applicator tip and the Everstick fibre was slowly inserted to ensure its snugly fit. Coronally the fibres were fanned out for retention of composite core and it was light cured for 45 seconds. In Group 4, post space preparation was done with paeso reamers size 2 and required Ribbond fibre length was cut and wetted with Te-Econom Bond [Ivoclar, Vivadent] and placed into the respective canal spaces and cemented with Te-Econom flowable composite and light cured for 45 seconds. In groups where Everstick and Ribbond were used core build-up was done using composite [Tetric-N-Ceram, Ivoclar, Vivadent].

All the samples were mounted in an acrylic block and a metal jig was created to hold the acrylic block in the universal testing machine so that force will be applied labially at the junction of incisal third and middle third [Fig 1]. Load was applied at a cross head speed of 0.5mm / second until fracture occurred and the values were recorded. The recorded values were entered in a Microsoft excel sheet and statistically analysed.

Statistical Analysis and Results:

The data were analysed using SPSS software [Vs 17.0.2]. Data was statistically analysed using one way ANOVA followed by Dunnett test for multiple comparisons. Table 1 shows the mean and standard deviation of the fracture loads in newtons. The fracture load ranged from 100 to 300 Newtons. The mean fracture load recorded in Parapost

(Group 2), Everstick (Group 3) and Ribbond group (Group 4) were 238 N, 222N and 134 N respectively. The fracture load of group 1 (Control group) was 393 N. The p value was found to be 0.001. Parapost group where fragment reattachment has been done showed higher fracture resistance values followed by Everstick group and Ribbond group

Table 2 shows the comparison of the fracture loads of test groups with the positive control. Mean difference were calculated among the groups. When the fracture resistance values were compared with the control group, the Parapost group showed values nearer to the control group whereas Ribbond fibre group showed values significantly lower than the control group whereas Everstick group was intermediate between them.

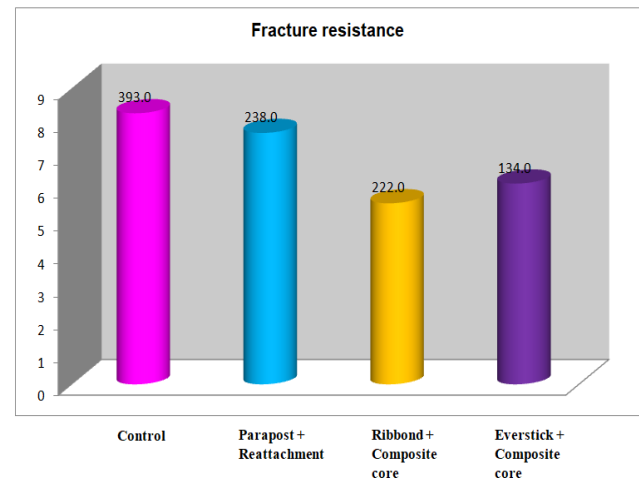
Graph 1 shows the comparison of fracture resistance values among the four groups.

Table 1: Mean and standard deviation of fracture resistance values observed among the four groups:

Sample [n]	Mean	Std Deviation	Std error	95% confidence interval for mean		Min	Max	
				Lower bound	Upper bound			
Control	10	393.0000	197.71191	62.52200	251.5654	534.4346	10.00	640.00
Parapost	10	238.0000	110.33283	34.89030	159.0726	316.9274	80.00	380.00
Everstick	10	222.0000	120.25898	38.02923	135.9719	308.0281	120.00	470.00
Ribbond	10	134.0000	86.56404	27.37395	72.0758	195.9242	20.00	330.00

Table 2: Intergroup comparison done using Dunnett test [* The mean difference is significant at the 0.05 level]

Group [I]	Group [J]	Mean difference	Standard error	Significance
Parapost	Control	-155.00000 *	60.50574	.039
Everstick	Control	-171.00000 *	60.50574	.021
Ribbond	Control	-259.00000 *	60.50574	.000



Graph 1: Comparison of fracture resistant values among the groups

Discussion:

In this study, fracture resistance of endodontically treated teeth restored with different fibre post systems were investigated. Since prevalence of dental injuries is high with maxillary anteriors¹⁸, those teeth were alone included in this invitro study design.

The coronal fragments were sectioned at the junction of incisal 2/3rd and cervical 1/3rd for mimicking the clinical condition of crown fracture. Various methods of obtaining tooth fragment are placing small notches on two proximal surfaces, fracturing the teeth using narrow forceps or a blunt instrument without making notches. Badami and Reis have shown that the surface of a sectioned tooth is different from a naturally occurring fractured one, as the fracture produces fragments with a good fitting.¹⁹ In this study, the teeth were cut in a standardized manner with a mounted disc. The cut was made in the cervical 1/3rd of the crown so as to enable better handling of the tooth fragment during reattachment. Using a disc results in smooth surfaces, which is an advantage as the number of defects in the adhesive interface is lower and allows to standardize the mode of "fracture"¹⁹.

For the past 15 years, fibre reinforced endodontic posts have been studied and described in the literature. Apart from the diameter of the post and post design, other factors such as fibre diameter, fibre density, orientation of the embedded fibres and their length, type of matrix used and strength of the interfacial bonding influences the mechanical properties of the post. Three different fibre post systems were used in the present study namely, Parapost, Everstick and Ribbond.

Parapost [Coltene Whaledent] is a cylindrical, conical type of post that consists of unidirectional glass fibres embedded in epoxy resin matrix. The fibre diameter ranges from 8.83µm to 16.97 µm and the fibres/matrix ratio were



Figure 1: Sample mounted under the universal testing machine by using a custom-made metallic Jig and tested for fracture resistance

found to be ranging from 40 to 55% which showed better flexural strength and hardness.²¹

The Everstick fibres [GC, Europe], which comes in a mouldable form could be polymerized into a rigid one after placing into the canal. Everstick fibre has difference in the polymer matrix. Polymethylmethacrylate [PMMA] chains with a molecular weight of 220KD plasticize the cross-linked Bis-GMA based matrix, thus reducing the formation of stress in the fibre-matrix interface during deflection.²² They are composed of mainly E-glass fibres. E-stands for electric – made up of aluminoborosilicate glass with less than 1 wt% of alkali oxides. A chemical composition of E-glass fibres include SiO₂ 54 wt%, Al₂O₃ 14 wt%, CaO, MgO 22 wt%, B₂O₃ 10 wt% and Na₂O + K₂O less than 2 wt%.²³

Ribbon fibre uses a bondable reinforcement fibre consisting of polyethylene woven fibres treated with cold gas plasma. These fibres embedded in conventional resin composite were advocated for coronal-radicular stabilization of pulp-less teeth. It is passive and highly reliable.²⁴

In the present study, Ribbon fibres and Everstick fibres were placed in the root canal space followed by composite core build-up, whereas in Parapost group, the sectioned coronal fragment was reattached and fracture resistance was measured. The results showed superior fracture resistance values with Parapost group where fragment reattachment was done. This could be due to the Bis-GMA matrix that contained least amount of fibres which reduced stress formation in the fibre-matrix interface during deflection. The result is in accordance with the previous report where moderately good values of fracture resistance was given by Parapost²⁵. Studies have shown that fracture load reduction after thermo cycling was lesser with Parapost²².

The group with Everstick fibre and composite core build-up showed fracture resistance values next to Parapost group. Interestingly, Everstick fibres presented higher flexural strength values in invitro studies evaluating flexural properties. This could be due to the optimization of the polymer matrix and the fibre properties to function as a composite material²². This was in accordance with the previous literature by Chakmakehi et al, who showed that the teeth which received Everstick were associated with highest fracture resistance of 1780.30±155.2 in newtons²⁶.

The group with Ribbon fibres and composite core build-up showed least fracture resistance. Literature has also reported better resistance values with Ribbon fibres. An invitro study showed a significant fracture resistance when this memory-free plasma treated fibre were combined with a double-taper light post to reinforce the root²⁷.

In Parapost group, the sectioned fragment was reattached to mimic the clinical condition of fragment reattachment

after complicated crown fracture. This group showed good fracture resistance also. Through reattachment procedures, wear could be maintained similar to adjacent tooth, colour matching can be easily done to the remaining coronal portion, incisal translucency could be preserved, original contour could be maintained, durable than composite core, occlusal contact could be maintained, positive response could be elicited from the patient²⁹.

It should be taken into account that this present study was an in vitro study design and the in vivo clinical condition cannot be completely simulated. So the need for future in vivo and in vitro study design could provide better scientific validation

Conclusion

Within the limitations of the present in-vitro study the following conclusions could be made:

1. Placement of fibres had significant effect on the fracture resistance of Endodontically treated teeth.
2. Results dictate the necessity of firm post for Reattachment procedures.
3. When compared, Parapost showed significant fracture resistant values than Everstick and Ribbon.

References:

1. Arnaldo Castelluci: John D West. Endodontics Volume III. Florence: IL Tridente, cop. 2005
2. Battistone, G., Burnett, G.W.: Studies on the composition of teeth III. The amino acid composition of human dentinal protein. *J Dent Res.* 35:255-259, 1956.
3. Helfer, A.R, Melnick, S., Schilder, H.: Determination of the moisture content of vital and pulpless teeth. *Oral Surg.*34:661-669, 1972.
4. Pashley, D.H., Tay, F.R, Yiu, Cky, Hashimoto, M., Breschi, L., Ito, S.: Collagen degradation by host-derived enzymes during aging. *Dent Res.* 83:216-221, 2004
5. Rivera, E., Yamauchi, G., Chasldler, G., Bergenholtz, G.: Dentin collagen cross-links of root-filled and normal teeth. *J Endod.* 14:195, 1988
6. Sheth J.J., Fuller, J.L., Jensen, M.E.: Cuspal deformation and fracture resistance with dentin adhesives and composites. *J Prosthet Dent.* 60:560-561, 1988.
7. Assif, D., Gorfil, C.: Biomechanical consideration in restoring endodontically treated teeth. *J Prosthet Dent.*1994 71:565-7
8. Cecilia Bourguignon, Asgeir Sigurdson. Preventive strategies for traumatic dental injuries. *Dent Clin N Am* 2009;53:729-49.
9. Begum Akkayan, Turgut Gulmiz. Resistance to fracture of endodontically treated teeth restored with different post systems. *J Prosthet Dent* 2002;87:431-7.
10. Tijan AH, Grant BE, Dunn JR. Microleakage of composite resin cores treated with various dentin bonding systems. *J Prosthet Dent* 1991;66:24-9.
11. Yang HS, Lang LA, Molina A, Felton DA. The effects of dowel design and load direction on dowel-core restorations. *J Prosthet dent* 2001;85:558-67.
12. Christel P, Meunier A, Heller M, Torre JP, Peille CN. Mechanical properties and short-term in-vivo evaluation of yttrium-oxide-partially stabilized zirconia. *J BioMed Mater Res* 1989;23:45-61.
13. Goracci C, Ferrari M. Current perspectives on post systems: a literature review. *Aust Dent J.* 2011;56(1):77-83.

14. Cagidiaco MC, Goracci C, Garcia-Godoy F, Ferari M. Clinical studies of fibre posts. A literature review. *Int J Prosthodont* 2008;21(4):328-36.
15. Maccari PC, Concei Cao EN, Nuner FM. Fracture resistance of endodontically treated teeth restored with three different prefabricated esthetic posts. *J Esthet Restor Dent* 2003;15(1):25-30.
16. Malferrari S, Monaco C, Scotti R. Clinical evaluation of teeth restored with quartz fibre reinforced epoxy resin posts. *Int J Prsthodont*. 2003;16:39-44.
17. Monticelli F, Grandini S, Goracci C, Ferrari M. Clinical behaviour of translucent fibre posts. A 2-year prospective study. *Int J Prosthodont*. 2003;16:593-6.
18. Shayegan A, De Martetaer V, Vanden Abbeele A. The prevalence of traumatic dental injuries. A 24-month survey. *J Dent Child*. 2007;74:194-9.
19. Loguercio AD, Mengarda J, Amaral R, Kraul A, Reis A. Effect of fractured or sectioned fragments on the fracture strength of different reattachment techniques. *Oper dent*. 2004;29:295-300.
20. Callister WD. Materials science and engineering: an Introduction. Composites 3rd ed. New York: Wiley: 1997.513-541.
21. Victor Alouso de la Pena, Iria L darriba, Martin Caserio Valea, Francisco Guitian Rivera. Mechanical properties related to the microstructure of seven different fibre-reinforced composite posts. *J Adv Prosthodont*. 2016;8:433-8.
22. Lippo VJ, Larrila, Johanna Tanner, Anna-Maria. Le Bell, Kalja Narva, rekka K Vallittu. Flexural properties of fibre reinforced root canal posts. *Dent Mater* 2004;20:29-36.
23. Meng Zhang, Jukka Pekka, Matinlinna. E-Glass fibre reinforced composites in dental applications. *Silicon*.2012;4:73-8.
24. Mayor Hegde, Sureshchandra B. Estetic posts- An Update. *J Endodontology*. 2012;24:102-9.
25. Frank Seefeld, Hans Jurgen, Klaus Ludwig, Mathias Kern. Resistance to fracture and structural characteristics of different fibre reinforced post systems. *Dent Mater*. 2007;23:265-71.
26. Chakmakchi M, Rasheed R, Suliman R. In vitro comparative assessment of fracture resistance of roots restored with Everstick fibre reinforced composite post. *J Oral Dent Res*.2015;2:43-50.
27. Vajihesadet Mortazavi, Mohammed Hossein, Najmeh Katiraei, Shirin Shahnesesi, Hamid Badrian, Navid Khalighinijad. Fracture resistance of steucturally compromised and normal endodontically treated teeth restored with different post systems: An invitro study. *Dent Res J*. 2012;9(20):185-91.
28. Nitin Malin, Shipra Nangalia Maitin, Khushboo Rastogi, Rajaishi Bhrhan. Fracture tooth fragment reattachment. *BMJ Case Rep*. 2013;12
29. Cavalleri G, Zerman N. Traumatic crown fractures in permanent incisors with immature roots: a follow-up study. *Endod Dent Traumatol*. 1995;11:294-6