FRACTURE RESISTANCE OF PALATAL CUSP OF MAXILLARY FIRST PREMOLAR RESTORED WITH DIFFERENT CORE MATERIALS – AN EX VIVO STUDY

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In partial fulfillment for the Degree of

MASTER OF DENTAL SURGERY

BRANCH IV

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CERTIFICATE

This is to certify that this dissertation titled **"FRACTURE RESISTANCE OF PALATAL CUSP OF MAXILLARY FIRST PREMOLAR RESTORED WITH DIFFERENT CORE MATERIALS - AN EX VIVO STUDY"** is a bonafide record of work done by **Dr.R.SRINIVASAN** under our guidance during the study period between **2008 -2011.**

This dissertation is submitted to **THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY**, in partial fulfillment for the degree of **MASTER OF DENTAL SURGERY – CONSERVATIVE DENTISTRY AND ENDODONTICS, BRANCH IV**. It has not been submitted (partial or full) for the award of any other degree or diploma.

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REVIEW OF LITERATURE

Morin et al (1984)[29] evaluated the deformation of cusp under occlusal force using strain gauges mounted on maxillary premolars with MOD preparations. The study concluded that deformation of the cusp under occlusal force in bonded restorations showed less hysteresis when compared with non bonded restorations.

Caval et al (1985)[7] evaluated several factors involved in cuspal fracture. The study concluded that restoring the cusps with amalgam or cast metal would protect the weakened cusp.

Reeh et al (1989)[43] examined the cuspal stiffness of various restoration techniques for pulpless teeth, using strain gauges. The study concluded that cast gold were the strongest restorative material and amalgam was the weakest and Composite restoration and enamel plus dentin etch were almost or strong as the unaltered tooth.

Bex et al (1992)[4] compared the resistance to failure of two restorative protocols for endodontically treated teeth. The study concluded that dentin bonded resin post core restorations provided significantly less fracture resistance.

Kovarik et al (1992)[22] compared three core materials that are used with prefabricated stainless steel posts. The study concluded that amalgam cores had the lowest failure rate, followed by composite resin cores. All teeth restored with crowns over glass-ionomer core buildup had higher failure rate.

Kahn et al (1996)[20] compared the resistance of three prefabricated threaded postsystems against lateral shearing forces. The study concluded that there were no statistically significant differences among threaded posts in each test group.

Cohen et al (1996)[9] evaluated the fracture load of four core materials supported by five post designs. The study concluded that no significant difference in fracture resistance for composite and amalgam core.

Utter et al (1997)[52] evaluated the effect of cementing procedures on retention of prefabricated metal posts.Twelve prefabricated posts were cemented in extracted teeth with zinc phosphate cement,14 with resin cement. The posts cemented with resin cement had significantly higher tensile strength than those cemented with the two zinc phosphate cement treatments.

Raiden et al (1999)[41] evaluated the diameter of the post space instrument for maxillary first premolars. The results showed that the minimum residual thickness was when 0.70 mm instruments were used in single-canal roots and when 1.10 mm or smaller instruments were used for two-canal roots.

Sirimai et al (1999)[47] compared the resistance to vertical root fracture of extracted teeth treated with various post core systems. The study concluded that polyethylene woven fiber with composite resin core resulted in significantly fewer vertical root fractures.

Steele et al (1999)[50] the fracture resistance of endodontically treated premolars restored with and without bonding agents. The study concluded there was no significant difference in fracture strength between the experimental groups.

Bonilla et al (2000)[6] compared the fracture toughness of several core materials. The study concluded that titanium-reinforced composite resin, the composite resin with fluoride, and amalgam materials showed fracture toughness most likely to withstand the stresses generated during mastication.

Al-Hazaimeh et al (2001)[1] investigated the effect of a ferrule preparation on the fracture resistance of crowned central incisors incorporating a prefabricated post cemented with resin cement and with a composite core. The study concluded that when composite cement and core materials were utilized the additional use of a ferrule preparation has no benefit in terms of resistance to fracture.

Fernandes (2001)[12] provided a review that indicated (1) preservation of tooth structure is a must; (2) posts should not be used with the intention of reinforcing the tooth; (3) review of functional and parafunctional forces must be undertaken before restoring the tooth, as these will influence the prognosis; and (4) controlled prospective clinical studies evaluating each factor should be undertaken.

O'Keefe et al (2001)[35] evaluated the effect of polymerization mode of resin composite core materials and dental adhesives on bond strength to dentin. The study concluded that there were incompatibilities between self cure core material and dual cure adhesives.

Lee et al (2001)[23] evaluated the fracture toughness of eight currently available core materials. The study concluded that highest fracture toughness were recorded by composite core and the least was shown by ketac molar core.

Llena–Puy et al (2001)[24] studied case histories of patients with post endodontic VRF and the effect of various pretreatment and posttreatment factors related to VRF. The study concluded that teeth restored with conventional amalgam took significantly longer to undergo VRF .

Nissan et al (2001)[34] investigated the use of reinforced composite resin cement as compensation for reduced dowel length.The study concluded that Flexi-Flow reinforced composite resin cement significantly increased retention of ParaPost and Dentatus dowels compared with zinc phosphate ,even if the length of the post is reduced

Fennis et al (2002)[11] This study revealed that complete cusp fracture is a common phenomenon in dental practice and has shown differences in cusp fracture with respect to tooth type and restorative status of the tooth. Teeth with a history of endodontic treatment are susceptible to unfavorable subgingival fracture locations

Hayashi et al (2002)[16] evaluated the fracture resistance of pulpless teeth restored with post cores and crowns. The study concluded that Cast post and cores offered least resistance to fracture and the type of fracture was also unfavorable.

Heydecke et al (2002)[17] conducted a literature review to compare the clinical and in vitro performance of cast posts and cores to that of direct cores with prefabricated posts in single-rooted teeth. The survival for cast posts and cores in 2 studies ranged from 87.2% to 88.1% and in a third study reached 86.4% for direct cores after 72 months.

Hsu Yu Bin et al (2002)[18] determined the number of load cycles to cement failure in maxillary incisors restored with bonded composite core. The study revealed that bonding of a composite core to dentin prior to crown cementation provided significantly stronger crown retention under fatigue loading.

Oviir et al (2002)[36] determined whether coronal coverage of endodontically treated teeth improves the tooth survival. The study concluded that the hazard for tooth loss was 6 times higher for teeth without crowns.

Naoum et al (2002)[30] ,provided an overview of the materials and techniques used for short- and long-term restorations during and immediately after endodontic treatment, and to make clinical recommendations. The study concluded that further research would be necessary to determine the effectiveness of temporary restorations in the conditions of the oral environment

Pilo et al (2002)[40] examined the effect of core stiffness on the fracture resistance and failure characteristics of a crowned, endodontically treated tooth under simulated occlusal load. The study concluded that core stiffness did not affect the failure resistance of teeth restored with posts and cores and complete-coverage cast metal crowns.

Assif et al (2003)[2] assessed the resistance to fracture of endodontically treated molars with various degrees of tooth structure loss restored with amalgam under simulated occlusal load**.** The study concluded that the endodontically treated molars with a conservative endodontic access or cuspal coverage with amalgam presented the highest resistance to fracture under a simulated occlusal load.

Hu Yun. Hsin et al (2003)[19] evaluated the fracture resistance of endodontically treated teeth restored with four post and core systems. The study concluded that significant difference in the failure loads among groups were present.

Mezzono Elio et al (2003)[27] evaluated the fracture resistance of teeth restored with Cast post and cores with and without ferrule using zinc phosphate and resin cement in maxillary 1st premolars. The study concluded that using resin cement without the ferrule had fracture resistance that were not statistically different from the ferruled groups.

Newman et al (2003)[31] compared the effect of 3 fiber-reinforced composite post systems and 1 stainless steel on the fracture resistance and mode of failure of endodontically treated teeth. Results from the study showed that the load to failure of the stainless steel posts were significantly stronger than all the composite posts studied.

Zhi-Yue et al (2003)[54] investigated the effects of post-core design and ferrule on the fracture resistance of root canal treated human maxillary central incisors restored with metal ceramic crowns. The study concluded that teeth prepared with a 2-mm dentin ferrule more effectively enhanced the fracture strength of custom cast post-core .

Zidan et al (2003)[55] evaluate the effect of amalgam bonding on the stiffness of teeth weakened by cavity preparation. Restoring the prepared tooth with bonded amalgam or with bonded composite recovered a significant portion of the lost tooth stiffness. It was concluded that bonding amalgam to tooth structure could partly restore the strength and rigidity lost by the cavity preparation.

Bolhuis et al (2004)[5] evaluated the influence of fatigue loading on the quality of the cement layer between posts with restricted lengths and the root canal wall in endodontically treated premolars. The study concluded that composite core build up material bonded to dentin and supported by quarter fibre post may be used as a alternative for Cast core. The cement integrity with the titanium post was significantly less than the other three systems.

Schwartz et al (2004)[45] reviewed post placement and restoration of endodontically treated.In the study recommendations were made for treatment planning, materials, and clinical practices from restorative and endodontic perspectives

Yamada et al (2004)[53] evaluated the fracture resistance of endodontically treated maxillary premolars with access cavities restored using various restorative materials and curing agents. The study revealed that fracture resistance was greatest for teeth restored using a cast metal onlay cemented with adhesive resin cement in endodontically treated maxillary premolars with MOD cavities.

Rasheed et al (2005)[42] determined the effect of a bonded amalgam restoration on reinforcement of weakened tooth structure. The study concluded that the use of resin cement increased the fracture resistance of the tooth with an MOD amalgam restoration.

Cheung et al(2005)[8] provided a review of the principles for the use of post and core, crowns and the different materials available to help clinicians make a clinical decision based on sound evidence.

Goto et al (2005)[14] compared fatigue resistance of 3 dowel-and-core systems. The study concluded that fibre -reinforced resin dowels and bonded composite cores under fatigue loading provided significantly stronger crown retention than cast gold dowels and cores and titanium alloy dowels with composite cores under fatigue loading.

Hanning et al (2005)[15] investigated whether reinforcement of endodontically treated premolars with MOD preparations could be achieved by insertion of bonded CAD/CAM ceramic inlays. The study concluded that teeth restored with bonded CAD/CAM ceramic inlays fractured with a significantly higher number of severe fractures compared to the control group.

Melo et al (2005)[26] evaluated the influence of remaining coronal tooth structure on endodontically treated teeth restored with prefabricated posts and two different composites for core build- The study concluded that the highest values of fracture resistance were found in the group restored with light-cured resin and remaining coronal tooth structure did not influence the resistance of endodontically treated teeth

Peroz et al (2005)[39] performed a literature review to create guidelines for the reconstruction of endodontically treated teeth by posts and cores. The study concluded that remaining tooth structure is an important factor influencing the indication of posts and cores, yet it is not sufficiently recognized in clinical studies and in vitro.

Tan et al (2005)[51] investigated the resistance to static loading of endodontically treated teeth with uniform and nonuniform ferrule configurations. results demonstrated that central incisors restored with cast dowel/core and crowns with a 2-mm uniform ferrule were more fracture resistant compared to central incisors with nonuniform (0.5 to 2 mm) ferrule heights.

Oviir et al (2006)[37] asesed the restoration of endodontically treated premolars with minimal tooth loss (Class II) in patients with mean age of 45 years . The study concluded that more root fractures with the amalgam buildup compared to the fiber post and composite core and more secondary caries with the fiber post and composite core than with the amalgam buildup.

Aykent et al (2006)[3] evaluated the effects of 2 dentin bonding agents and a ferrule preparation on the fracture resistance of crowned mandibular premolars incorporating prefabricated dowel and silver amalgam cores. The study concluded that ferrule preparation or a bonding agent each increase the fracture strength for teeth receiving cast crowns after endodontic therapy.

Colak et al (2007)[10] evaluated the fracture resistance of 3 core materials. The study concluded that glass ionomer core with custom post was the weakest post core system. While the prefabricated posts with resin composites and amalgam cores were the strongest post and core systems

Geiger et al (2008)[13] evaluated the fracture resistance of endodontically treated teeth restored with combined composite amalgam restoration using Instron testing machine. The study concluded that restoring endodontically treated teeth with combined composite amalgam restoration should higher resistance to fracture .

Nissan et al (2008)[32] evaluated the influence of reduced post length on fracture resistance of crowned endodontically treated teeth with a 2 mm ferrule on healthy tooth structure. The study concluded that post length did not influence the fracture resistance of crowned endodontically treated teeth with a 2 mm ferrule on healthy tooth structure.

Nissan et al (2008)[33] evaluated the fracture resistance of crowned endodontically treated teeth (maxillary 1st premolar) preserving various degree of remaining coronal tooth structure. Forces at fracture and mode of failure were recorded. The study concluded that remaining coronal tooth structure influenced the fracture resistance of crowned endodontically treated maxillary first premolars. Preservation of tooth structure is more important for its protection against fracture at the occlusal load.

Schmitter et al (2008)[44] evaluated the fracture resistance of teeth restored using an adhesive core material placed under artificial crowns. He concluded that fracture strength of adhesive crown/core complexes were greater.

Sengun et al (2008)[46] investigated the effect of a new fiber-reinforced composite restoration technique on fracture resistance in endodontically treated premolars. The study concluded that fracture of the teeth reinforced with a combination of polyethylene fiber and composite resin produced a more favourable failure modes limited to the level of the enamel.

Soares et al (2008)[48] evaluated the fracture resistance, stress distribution, and cusp deformation of endodontically treated human maxillary premolars restored with different materials. Teeth with the greatest amount of remaining tooth structure and those restored using adhesive technology showed higher fracture resistance values.

Soares et al (2008)[49] analyzed the influence of cavity design and restorative material on strain measurement and stress distribution in maxillary premolars using strain gauge test. The specimens with adhesive restorations were shown to behave in a manner similar to the biomechanical behavior of healthy teeth.

Karapinar et al (2009)[21] evaluated the fracture resistance of teeth filled with various canal filling materials. The study concluded that systems aiming to obtain a monoblock system were not superior to the conventional AH-Plus + Gutta-percha technique in terms of fracture resistance.

McLaren et al (2009)[25] compared the fracture resistance and mode of failure of endodontically treated teeth restored with 3 different post systems, including 2 fiber-reinforced posts and a stainless steel post. The study concluded that stiffness and the load to initial fracture of the teeth restored with stainless steel posts were higher compared with the fiber-reinforced post groups.

Monga et al (2009)[28] fracture resistance of endodontically treated teeth using different coronal restorative materials. Conventional amalgam core showed the least fracture resistance whereas; composite resin and bonded amalgam core showed fracture resistance was similar to that of natural tooth.

MATERIALS AND METHODS

MATERIALS

1. 48 extracted,intact,human, maxillary, first,premolar
2. Gutta-percha(Dentsply,Maillefer)
3. AH plus root canal sealer (Dentsply DeTrey, Konstanz, Switzerland)
4. Tapered threaded prefabricated stainlees steel metal post (Referopost I, angelus)
5. Flexi-Flow titanium reinforced composite resin cement(EDS)
6. 37% phosphoric acid(3M ESPE)
7. Adper Scotchbond multipurpose plus (3M ESPE)
8. The composite resin (Filtek P60, 3M ESPE)
9. High-copper amalgam [Dispersalloy, Dentsply]
10. Ketac molar(Easymix,3M ESPE)
11. IRM (Densply)
12. Cylindrical moulds (2.5 cm × 2.5 cm)acrylic resin blocks
13. Self-cure clear acrylic resin [Ashwin Pvt. Ltd. India]
14. Physiological water (0.85 % of saline)
15. Vinyl polysiloxane impression material (Ivoclar)

16. Die stone(Kalabhai,Gujarat,India)
17. Zinc phosphate cement(Panavia)

ARMAMENTARIUM

1. Digital vernier callipers (Gros,general,USA)
2. Ultrasonic scaler(EMS ultrasonic scaler)
3. EndoAccess bur (Mani, Inc, Tochigi, Japan)
4. Diamond disc
5. No.3 paesso raemer (Mani, Inc, Tochigi, Japan).
6. Air syringe.
7. Light curing unit(Spectrum 800,Densply)
8. Chamfer finishing bur(SS white)
9. Incubator
10. Thermocycling unit
11. Instron Universal Testing Machine

METHODOLOGY

Forty eight extracted, intact, human, maxillary,first premolar teeth were selected. The teeth selected had anatomical crown similar in dimension (8 ±1mm buccopalatal,7±1 mm mesiodistal) and were standardised using digital vernier callipers .All soft tissue and debris on the teeth were removed using an ultrasonic scaler. The teeth were randomly divided into six experimental groups of 8 teeth each and subjected to the following procedures:

Group 1 – Intact teeth prepared for full cast metal coronal restoration (control).

Group 2 – Endodontic access cavities were prepared using EndoAccess bur. The root canals were instrumented to a size 35 K file and filled with gutta-percha and AH plus root canal sealer using a lateral condensation technique. Palatal cusp of the premolar teeth was removed using diamond disc upto the level of 1mm from the CEJ. Buccal wall was retained. 5mm post space preparation was done in the palatal root using No.3 paesso raemer. Tapered threaded prefabricated stainless steel metal post of 9mm long was luted in the post space prepared using resin cement such that 4 mm of the core retaining part was above the CEJ.

Prior to the restoration with composite resin. Both enamel and dentine were etched with 37% phosphoric acid for 15 seconds. The surface was rinsed with water and the excess water was removed with an air syringe. Scotchbond multipurpose primer (bottle 2) was applied to the enamel and dentine and was dried gently for five seconds. Adper Scotchbond Multi-Purpose plus Adhesive was then applied to the enamel and dentine and light-cured for ten seconds as per manufacturer’s instructions. The composite resin was placed in the cavities in increments of 2 mm thickness, and each increment was light-cured for 20 seconds. After the removal of the matrix band, the restorations were contoured and polished.

Group 3 – The teeth were rootcanal filled and prepared as in group 2. Prior to the restoration with amalgam, the Adper Scotchbond Multi-Purpose plus Adhesive system was applied according to the manufacturer's instructions. Etchant (37% Phosphoric acid) was applied to the enamel and dentine for 15 seconds. The cavity was rinsed and excess water removed with a gentle, five-second air blast.

One drop each of activator (bottle 1.5) and primer (bottle 2) were mixed and applied to the etched enamel and dentine for 15 seconds; the preparations were dried gently for five seconds. One drop each of adhesive (bottle 3) and catalyst (bottle 3.5) were then mixed and applied to the primed enamel and dentine. The amalgam was mixed and placed before the bonding material had set. The restorations were then polished.

Group 4 – The teeth were rootcanal filled and prepared as in group 2. Cavities were restored with high-copper amalgam according to the manufacturer's instructions.

Group 5 – The teeth were rootcanal filled and prepared as in group 2. Cavities were restored with Ketacmolar according to the manufacturer's instructions.

Group 6 – The teeth were rootcanal filled and prepared as in group 2. Cavities were restored with thick mix of IRM.

Cylindrical moulds (2.5 cm × 2.5 cm) were made using acrylic resin blocks. Self-cure clear acrylic resin was used to fill the mould and the teeth mounted to 2 mm level apical to the cemento-enamel junction.

All the teeth were stored in physiological water (0.85 % of saline)for 48 hrs and then prepared for full cast metal crowns with a chamfer finish line 1mm apical to the core-tooth junction for getting a 1mm ferrule on healthy tooth structure .Vinyl polysiloxane impressions were made and poured with die stone and full cast metal crowns (Ni-Cr)were fabricated and cemented with zinc phosphate cement.

Samples were stored in 100% humid environment for 7 days at room temperature. The specimens were thermo cycled 1000 times between 5°C and 55°C for 30 seconds in each temperature and with 15 seconds rest time .Specimens were mounted in a jig that allowed loading of palatal cusp in a axio-occlusal line at a 30-degree angle to the long axis of the tooth.Continuous compressive speed of 2mm/min was applied by an Instron universal testing machine. Load at fracture (in kg) was recorded and the results were statistically evaluated.

METHODOLOGY FLOW CHART

48 extracted, intact, human, maxillary, premolar teeth were selected. The teeth selected had anatomical crown similar in dimension were standardised using digital vernier callipers.

↓

The teeth were randomly divided into six groups of 8 teeth each and subjected to the following procedures

↓

- Group I Intact teeth prepared for full cast metal coronal restoration(control)
- Group II(Endodontically treated ,palatal cusp removed,upto the level of 1mm from the CEJ,. 5mm post space preparation was done ,9mm TT post luted using resin cement in the palatal root) .The teeth were restored with composite core build up material
- Group III(teeth were root canal treated and prepared as in group II) and then the core restored with bonded amalgam restoration
- Group IV(teeth were root canal treated and prepared as in group II) and then the core restored with amalgam restoration
- Group V(teeth were root canal treated and prepared as in group II) and then the core restored with glass ionomer core material
- Group VI (teeth were root canal treated and prepared as in group II) and then the core restored with IRM core material

↓

Cylindrical moulds (2.5 cm × 2.5 cm) were made using acrylic resin blocks. Self-cure clear acrylic resin was used to fill the mould and the teeth mounted to 2 mm level apical to the cemento-enamel junction.

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↓

Load at fracture (in kg) was recorded and the results were statistically evaluated.

Fig.1: MATERIALS

Fig.2: DIGITAL VERNIER CALLIPERS

Fig.3: INCUBATOR

Fig.4: INSTRON UNIVERSAL TESTING MACHINE

Fig.5: SAMPLES

Fig.6: ACCESS OPENED

Fig.7: PALATAL CUSP REMOVED

Fig.8: POST SPACE PREPARED

Fig.9: POST COATED WITH RESIN CEMENT

Fig.10: POST PLACEMENT

Fig.11: POST LUTED

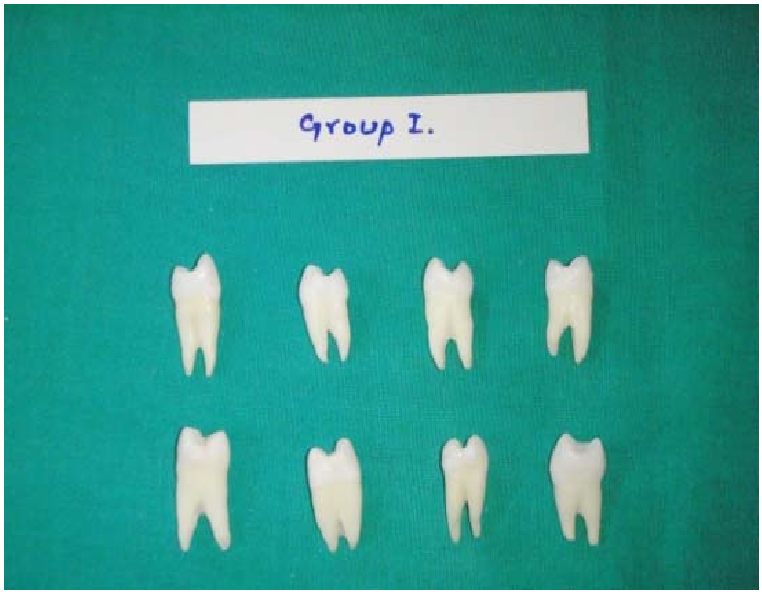


Fig.12: GROUP I (INTACT TEETH)

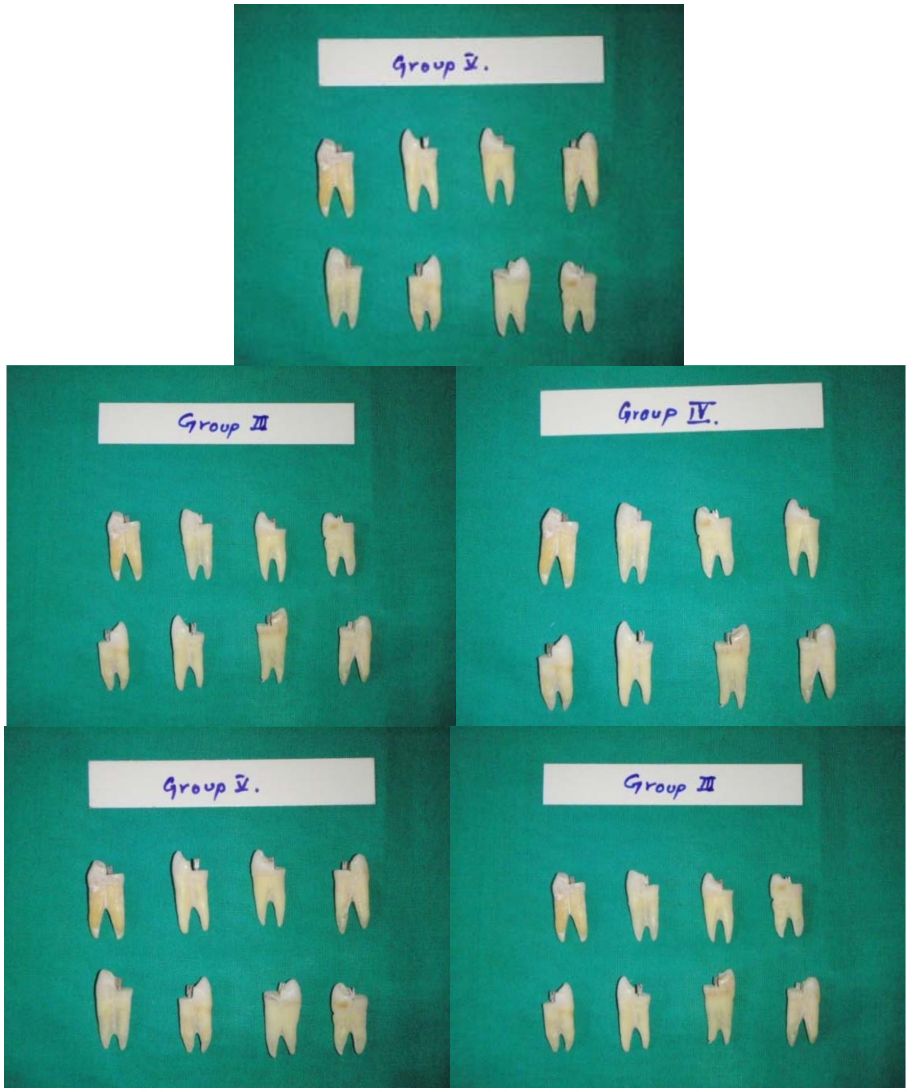


Fig.13 POST LUTED WITH RESIN CEMENT IN GROUPS (II-VI)

Fig.14: TEETH RESTORED WITH THEIR RESPECTIVE CORES IN

GROUPS (II-VI)

Fig.15: CROWN PREPARATION

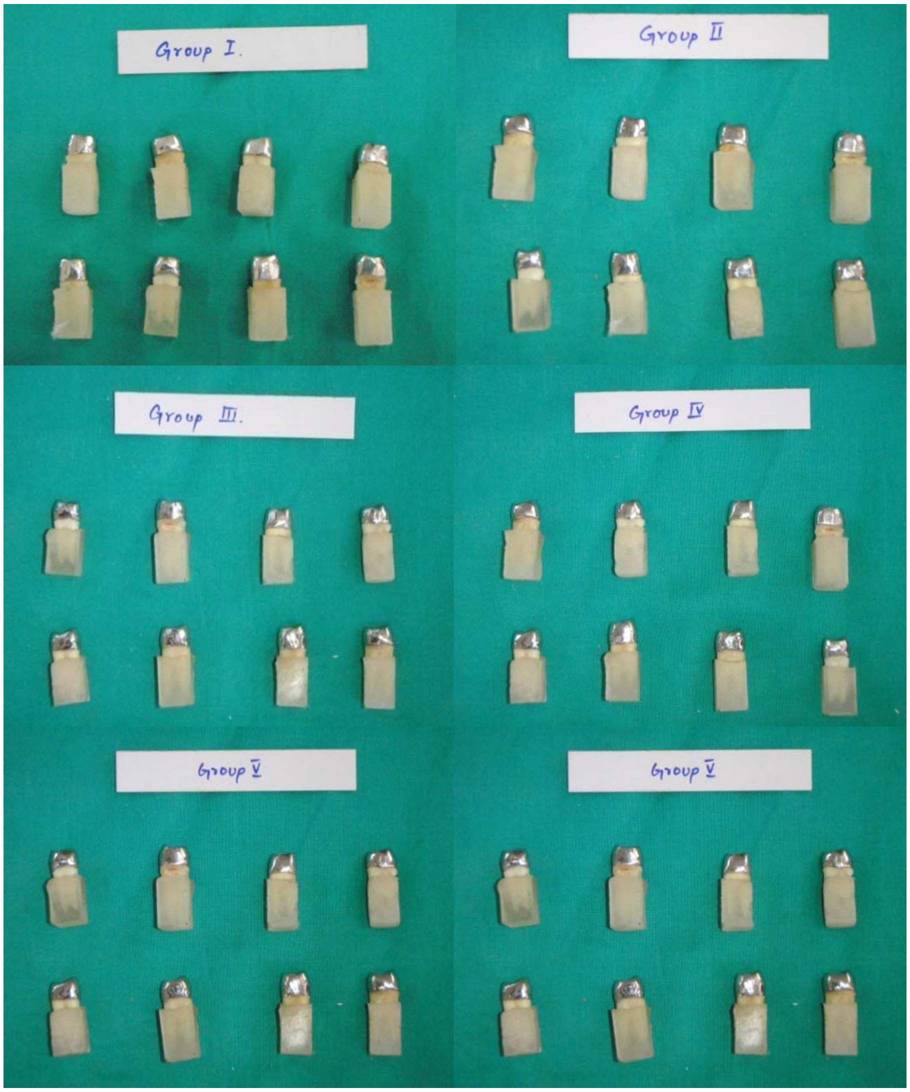


Fig.16: CROWN (Ni-Cr) LUTED WITH ZINC PHOSPHATE CEMENT

RESULTS

Table 1 shows fracture resistance of the samples and their mean values in Kgs.

Of the 6 groups tested in the present study, group I(intact teeth) recorded 87.36 kg, group II(composite core) recorded 83.3 kg, group III (bonded amalgam core) recorded 77.30kg ,group IV(amalgam core) recorded 75.46 kg, group V (glass ionomer core) recorded 71.4kg,group VI (IRM) recorded 67.31kg.

Table 2 shows the mean and standard deviation

Table 3 shows sum of square and the mean square values.

Table 4 shows multiple comparisons between the experimental groups and control.

STATISTICAL ANALYSIS

The results of the present study were subjected to statistical analysis to interpret the significant differences between the fracture resistance of various groups and also between the groups. One-way anova , Post Hoc Tukey HSD tests were used for statistical analysis

One–way Analysis of Variance is used to study the overall variance within groups. Its the extension between the t-test to the situation in which more than two groups are compared simultaneously. However, it is not possible to multiple comparisons between the groups with this test, hence forth Post Hoc Tukey HSD test is used in this study to compare the fracture resistance among the experimental groups and with the control groups.

p value-Level of significance is denoted by the p value and is usually set as 5%.This probability value indicates that the observed difference between the study group is a real difference and not by mere chance

In the present study One way Anova revealed statistical significant difference ($p<0.001$) between the experimental groups and the controls.Among the experimental groups, group I(composite core) recorded the highest fracture resistance value. There were no statistically significant difference between the results of group III(Bonded amalgam core) and group IV(Amalgam core).The mean fracture resistance of these two groups were significantly lower than group II(composite core), but higher than group IV(Glass ionomer core) and group VI(IRM).Group VI(IRM) recorded the least value.

To summarize:

1. Fracture resistance of the palatal cusp in intact teeth prepared for full cast metal coronal restoration was the maximum

2. Among the experimental groups fracture resistance of the composite as core material was the maximum

3. The fracture resistance of amalgam and bonded amalgam as core materials were not statistically significant

4. Among the experimental groups the fracture resistance of IRM core was the least followed by glass ionomer core (Ketac molar)

Table : 1

FRACTURE RESISTANCE IN KG						
	Group I	**Group II**	**Group III**	**Group IV**	**Group V**	**Group VI**
	Intact teeth	**Composite**	**Bonded Amalgam**	**Amalgam**	**Glass ionomer**	**IRM**
	88.0	83.8	80.7	73.9	70.7	68.5
	89.2	84.0	81.5	78.2	72.8	67.6
	86.1	82.5	76.4	74.2	69.8	66.5
	87.4	83.1	74.5	75.4	70.1	68.4
	88.1	84.2	75.8	76.2	71.5	67.6
	86.4	83.5	75.4	75.4	72.1	65.6
	86.5	82.4	76.9	75.8	73.1	66.2
	87.2	82.9	77.2	74.6	71.1	68.1
Mean	**87.36**	**83.3**	**77.3**	**75.46**	**71.4**	**67.31**
SD	**± 1.043**	**± 0.68**	**± 2.5**	**± 1.3**	**± 1.2**	**± 1.08**

Oneway

Table: 2

Fracture Resistance (in kg)

Descriptives

Fracture Resistence (in kg)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Group I	8	87.363	1.0433	.3688	86.490	88.235	86.1	89.2
Group II	8	83.300	.6803	.2405	82.731	83.869	82.4	84.2
Group III	8	77.300	2.5037	.8852	75.207	79.393	74.5	81.5
Group IV	8	75.463	1.3596	.4807	74.326	76.599	73.9	78.2
Group V	8	71.400	1.2059	.4264	70.392	72.408	69.8	73.1
Group VI	8	67.313	1.0829	.3829	66.407	68.218	65.6	68.5
Total	48	77.023	6.9709	1.0062	74.999	79.047	65.6	89.2

Table: 3

ANOVA

Fracture Resistence (in kg)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2197.839	5	439.568	214.507	.000
Within Groups	86.066	42	2.049		
Total	2283.905	47			

Table :4

Post Hoc Tests

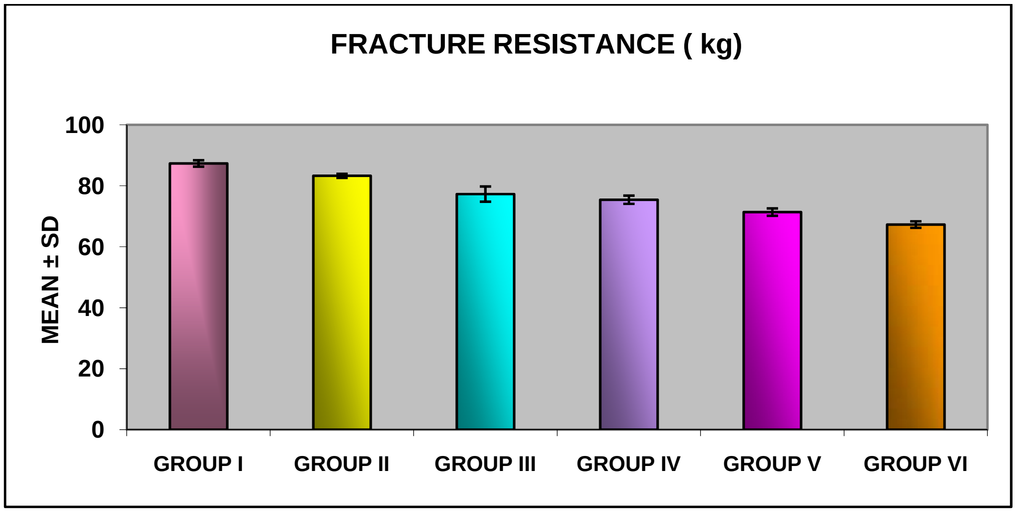
Multiple Comparisons

Dependent Variable: Fracture Resistence (in kg)
Tukey HSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Group I	Group II	4.0625*	.7158	.000	1.926	6.199
	Group III	10.0625*	.7158	.000	7.926	12.199
	Group IV	11.9000*	.7158	.000	9.763	14.037
	Group V	15.9625*	.7158	.000	13.826	18.099
	Group VI	20.0500*	.7158	.000	17.913	22.187
Group II	Group I	-4.0625*	.7158	.000	-6.199	-1.926
	Group III	6.0000*	.7158	.000	3.863	8.137
	Group IV	7.8375*	.7158	.000	5.701	9.974
	Group V	11.9000*	.7158	.000	9.763	14.037
	Group VI	15.9875*	.7158	.000	13.851	18.124
Group III	Group I	-10.0625*	.7158	.000	-12.199	-7.926
	Group II	-6.0000*	.7158	.000	-8.137	-3.863
	Group IV	1.8375	.7158	.128	-.299	3.974
	Group V	5.9000*	.7158	.000	3.763	8.037
	Group VI	9.9875*	.7158	.000	7.851	12.124
Group IV	Group I	-11.9000*	.7158	.000	-14.037	-9.763
	Group II	-7.8375*	.7158	.000	-9.974	-5.701
	Group III	-1.8375	.7158	.128	-3.974	.299
	Group V	4.0625*	.7158	.000	1.926	6.199
	Group VI	8.1500*	.7158	.000	6.013	10.287
Group V	Group I	-15.9625*	.7158	.000	-18.099	-13.826
	Group II	-11.9000*	.7158	.000	-14.037	-9.763
	Group III	-5.9000*	.7158	.000	-8.037	-3.763
	Group IV	-4.0625*	.7158	.000	-6.199	-1.926
	Group VI	4.0875*	.7158	.000	1.951	6.224
Group VI	Group I	-20.0500*	.7158	.000	-22.187	-17.913
	Group II	-15.9875*	.7158	.000	-18.124	-13.851
	Group III	-9.9875*	.7158	.000	-12.124	-7.851
	Group IV	-8.1500*	.7158	.000	-10.287	-6.013
	Group V	-4.0875*	.7158	.000	-6.224	-1.951

*. The mean difference is significant at the .05 level.

GRAPH : 1



X – axis : Groups used in the study

Y – axis : Mean ± SD

DISCUSSION

Endodontically treated teeth presents numerous problems because of coronal destruction from dental caries, fractures, and previous restorations or endodontic techniques. This results in a loss of tooth structure and a reduction in the capability of the tooth to resist a myriad of intraoral forces.

During endodontic treatment, there can be appreciable loss of dentin including anatomic structures such as cusps, ridges, and the arched roof of the pulpal chamber.[2]Dentin provides the solid base required for tooth restoration. Its structural strength depends on the quality and integrity of its anatomic form, so the fundamental requirement is the quantity of sound dentin remaining to retain and support the restoration.[2]

In endodontically treated teeth, the process of choosing the most suitable restorative technique and materials may be difficult, since such teeth are highly susceptible to fractures. When loads are applied to a structure, stresses causing structural strain are generated, but if such stresses become excessive and exceed the elastic limit, crack formation and structural failure may result.[49]

Most of the literature concerning restoration of the endodontically treated tooth has been focused on the post-core unit. In teeth with extensive tooth destruction, posts are advocated to retain the core that replaces lost coronal structure. The use of the post-core-crown to restore the tooth has been reported to play a significant role in resistance of the tooth to fracture.[12]

According to Schwartz et al[45] premolars are more likely to be subjected to lateral forces during mastication with delicate root morphology demanding special care during post space preparation. Moreover, endodontically treated maxillary first premolars has insufficient remaining tooth structure with radicular fluting.[33]

Another study by Hanning et al[15] reported that in vivo fracture of palatal cusps of maxillary premolars occur more frequently than the buccal cusps. Of the crowned endodontically treated teeth, Puy et al[24] reported premolars to be more often affected by vertical root fracture (VRF).

The core consists of a restorative material placed in the coronal area of the tooth. The core replaces the carious ,fractured ,missing coronal structure and retains the final restoration.[58]

Morgano and Brackett et al described some of the desirable features of a core material. They include ;

1. Compressive strength to resist intraoral forces
2. Sufficient flexural strength,biocompatibility
3. Resistance to leakage of oral fluids at the core-to tooth interface
4. Ease of manipulation
5. Ability to bond to remaining tooth structure
6. Thermal coefficient of expansion and contraction similar to tooth structure
7. Dimensional stability
8. Minimal potential for water absorption and inhibition of dental caries.

Unfortunately, as the commonly used materials all exhibit certain strengths and weaknesses, such an ideal core material does not exist.[8]

Core stability and post retention are important factors in preventing failures with restored pulpless teeth.[9]Core buildups are performed almost daily in restorative dental practices as substructures to support crowns or fixed partial denture retainers. Because of the many treatment alternatives available, often there is much confusion associated with choosing the most stable material or set of materials for a given procedure.[35]

Frequently used core materials in dentistry include amalgam, composites, and glass-ionomer cements. Silver amalgam remains a popular core material. Developments and advances in high copper amalgams and the new concepts of bonding amalgam to tooth structure have helped to ensure that amalgam remains one of the materials widely used for core foundations in posterior teeth.[3]

Amalgam, a widely used restorative material, has been characterized as technically easy to use and clinically predictable, with favorable mechanical properties.[49]According to Kovarik et al[22] teeth restored with amalgam cores had lower failure rates and amalgam cores provided significantly more rigid abutments for crowns and fixed partial dentures .

Another study by Assif et al[2] concluded that teeth restored to their original contour with high copper amalgam presented with high incidence of resistance to fracture under simulated occlusal load. In contrast to the above mentioned studies ,Oviir Tina et al[37]did a randomized clinical study and reported high incidence of catastrophic failures in amalgam core build-ups .

Recently, resin bonding agents have been introduced to provide an adhesive interface between tooth structure and dental amalgam. Eackle et al have suggested that the use of an adhesive resin liner beneath an amalgam restoration might increase the fracture resistance of a restored tooth. Pilo et al demonstrated that the use of amalgam bonding agents increased the resistance of cusps to fracture. In contrast, some studies found that bonded amalgam did not increase the fracture resistance of teeth, while amalgam bonding agents significantly increase retention of amalgam to tooth structure.[3]

Composite resin have been proposed as alternatives to amalgam, since these materials bond to tooth structure directly.[49]It offers several advantages such as strength ,bonding capabilities,ease of manipulation and rapid setting time when compared to amalgam.[10]On the negative side microleakage, dimensional stability[10],plastic deformation,un reliable bonding ,optimized isolation [45]questions the use of composite as an ideal core build up material.

Glass ionomer cements have some favorable characteristics, such as bonding to enamel and dentin, fluoride release, and a low coefficient of thermal expansion. The disadvantages of glass ionomer cements, including the metal-reinforced glass-ionomer materials, is that when they are used as core materials they lack inherent strength and are brittle.They should generally not to be used for high stress bearing situations.[22]

The post is a restorative material placed in the root of a structurally damaged tooth in which additional retention is needed for the core and the coronal retention .[58]

The primary purpose of a post is to retain a core in a tooth with extensive loss of coronal tooth structure[45] and support the crown. Posts should only be used when other options are not available to retain a core.[45]

Colak et al[10] classified post and cores designs into 2 basic types ;

1. Metal post and metal cores that are custom cast as a single piece

2. Commercially prefabricated posts on which cores are directly fabricated

Prefabricated posts are categorized in number of different ways. At the outset, Schwartz[45] classified them based on;

1. Mode of retention(active or passive)
2. Design(parallel or tapered)
3. Material composition.

Active posts are more retentive than passive posts, but introduce more stress into the root than the passive posts.[45]But according to Kahn et al[20] a threaded post was a non-contributory factor in radicular fracture. The same study states that posts are placed in an area of zero forces (the root canal),only minimally absorbs laterally applied forces and does not contribute to decreased radicular fracture resistance .The possibility of induction of incomplete fractures of radicular dentin as a result of instrumentation and obturation procedures weaken the dentin more after the endodontic therapy is a important contributory factor.

Because of the delicate root morphology present in some premolars, special care must be exercised when preparing a post space. Tapered posts require less dentin removal because most roots are tapered. They are primarily indicated in teeth with thin roots and delicate morphology.[45]Nissan et al[32] found out that resistance to fracture of crowned premolars with varying types of posts (parallel,tapered) luted with reinforced resin cement showed no statistical difference in the mean failure forces even when the length of the post is compromised .

In another study, Nissan et al[34] ,using reinforced resin cement for luting the posts, found out that mean retention values of posts luted with resin cements were more than the zinc phosphate cement.

In a similar study determining the retention of prefabricated metal posts Utter JD et al[52] found out that posts luted with resin cement exhibited a significantly higher resistance to dislodgment by axial tensile force than those cemented with zinc phosphate .

Nissan et al [34] states that the diametrical and the tensile strength of resin cement closely matches that of the dentin and is three times more than the zinc phosphate cement.

Many of the prefabricated posts are made of titanium alloys ,stainless steel and brass. Titanium posts were introduced because of concerns about corrosion. Most of the titanium alloys used in posts have a radiodensity similar to gutta-percha and sealer and are sometimes hard to detect on radiographs.

Titanium posts have low fracture strength, which means they are not strong enough to be used in thin post channels. Removal of titanium posts can be a problem because they sometimes break when force is applied with a post removal instrument. For these reasons, titanium and brass posts should be avoided, because they offer no real advantages over the stronger metal posts.[45]

In contrast to the tinanium posts, studies(Cormier et al 2001,Gallo et al 2002,Newman et al 2003) have shown that stainless steel posts had high failure threshold and are more retentive.[45]

Preservation of tooth structure is an important principle of the post space preparation. Whenever possible radicular tooth structure should be conserved,as resistance and retention of the posts are directly related to the remaining tooth structure .[45]

Raiden et al[41] has stated that the capacity to withstand the lateral stresses is directly propotional to the thickness of the tooth wall.The diameter of the post space preparation instrument for maxillary premolar with bifurcated roots was 1.1 mm. Usage of this size conserved 1mm of radicular dentin thickness circumferentially around the post space. The preservationists philosophy of post space preparation advised leaving 1mm of sound dentin surrounding the entire post.[59]

Peroz et al[39],in 2005 made an attempt to formulate a more detailed description for the amount of remaining dental tissue because the extent of destruction cannot be evaluated metrically. He describes 5 classes, depending on the number of remaining axial cavity walls.

1. Class I describes the access preparation with all 4 axial cavity walls remaining.
2. Class II describes loss of 1 cavity wall, commonly known as the mesio-occlusal (MO) or the disto-occlusal (DO) cavity.
3. Class III represents an MOD cavity with 2 remaining cavity walls.
4. Class IV describes 1 remaining cavity wall, in most cases the buccal or oral wall.
5. Class V describes a decoronated tooth with no cavity wall remaining.

According to Peroz et al[39] classes I,II,III has sufficient remaining hard tissue provides enough surface that does not necessitate the insertion of a post ,while classes IV and V presents a high degree of destruction where one or no cavity wall remains. The insertion of posts appears necessary if the tooth has to be used functionally.

According to Kahn et al[20], "many in vitro studies have used forces applied directly either to post heads or cores, but a tooth with a post and core is commonly restored with an artificial crown. A cast crown with a ferrule has been shown to distribute forces to the post and core and root more uniformly than forces applied directly to the post or core". In the same study it was stated that, a crown inserted with a 2 mm ferrule over a post and core in a photoelastic study, showed no differences between threaded and nonthreaded posts. The same posts, when loaded without incorporation of a crown, created stress concentrations at different areas of the post".

Retrospective study by Oviir Tina et al[36] has shown that crown placement increases long-term survival of endodontically treated teeth.

According to Kovarik et al[22] ,when the margins of the crowns were placed just below the margins of the core (<1.0mm of ferrule),the occlusal forces are largely borne by the post and core materials themselves.In the same study it was stated that when there is 2mm of ferrule below the margin of the core any core material is acceptable .

Kovarik et al[22] had stated that at times clinically when the remaining tooth structure was so scarce that the margins of the crown must be placed at or just below the core. Under these conditions the choice of the core materials becomes important.

So this study was done to determine the fracture resistance of various core materials, where the core was retained using tapered threaded stainless steel post in the palatal canal in endodontically treated maxillary first premolar and the crown was luted with zinc phosphate cement. This was compared with a intact tooth,(without endodontic treatment) prepared for a full cast metal restoration.

Hence the objective of this study was to

1. Evaluate the fracture resistance of the remaining palatal tooth structure restored with various core materials on endodontically treated maxillary first premolar with prefabricated post luted in the palatal root using resin cement
2. Compare the fracture resistance of various core materials with the intact tooth prepared for full cast metal restoration

In the present study, 48 intact, extracted, noncarious, human, maxillary first premolar teeth intended for orthodontic treatment were extracted and were selected .All soft tissue and debris on the teeth were removed using an ultrasonic scaler. The teeth were randomly divided into six groups of 8 teeth each .

The teeth in the control group was left intact. Endodontic access cavities were prepared in the teeth in the rest of the experimental groups using EndoAccess Bur. EndoAccess bur has a round tip with tapering head to form tapered endodontic access during rotation.

The root canals were instrumented to 35 size k file and filled with gutta percha using AH plus sealer. According to a study by

Kazandag et al[21],teeth filled using AH plus in combination with gutta percha using the lateral compaction method have no difference than a natural tooth in terms of resistance .

Palatal cusp of the premolar except in group I was removed using diamond disc upto the level of 1mm from the CEJ in order to simulate fractured palatal wall and Class IV condition as stated in Peroz's[39]classification. The buccal wall was retained .

5mm of post space preparation was done in the palatal root using no.3 paesso reamer. The diameter of no.3 paesso reamer is 1.1mm. A 1.1mm instrument conserves 1mm of radicular dentin around the post space prepared in the bifurcated maxillary first premolar,which was needed for resistance and retention.

Tapered threaded prefabricated stainless steel metal post of 9mm long was luted in the post space prepared using the resin cement. Tapered post match the delicate morphology of maxillary first premolar. Threaded posts were used to increase the retention. Stainless steel posts showed high failure threshold and were more retentive.[45]

All the prefabricated metal posts were luted using titanium reinforced resin cement such that 4mm of core retaining part was above the CEJ. Titanium reinforced resin cements has shown greater retention and resistance even if the length of the post was compromised, when compared to zinc phosphate cement.

The teeth were restored with their respective core-build up materials except in group I(control).In group I samples, no endodontic treatment was done This was done to evaluate the fracture resistance offered by the palatal cusp prepared for full cast metal coronal restoration and to compare it with the other experimental groups.

Cylindrical moulds were made and acrylic resin were used to fill the moulds. Teeth were mounted to 2mm apical to the CEJ.

All the teeth were stored in physiological water (0.85% of saline) to simulate oral saliva for 48 hrs and then prepared for full cast metal crowns with chamfer finish line 1mm apical to the core tooth junction for getting 1mm of ferrule on healthy tooth structure except in group I. In this situation occlusal forces were largely borne by the post and core materials themselves. In group I more than 2mm of tooth structure is available above the CEJ. This available dentin provides the solid base required for tooth restoration.

Vinyl polysiloxane impressions were made and poured with die stone. Full cast metal crowns were fabricated and cemented with zinc phosphate cement. Crown placement increases long-term survival of endodontically treated teeth. In this study, the amount of remaining dentin was approximately 1mm,a zinc phosphate was used as it on its own exhibited high compressive strength and greater resistance to elastic deformation when used as luting agents for restorations that are subjected to high masticatory stresses.[56]

Resin cements were not used for crown luting as the eugenol of the IRM group could interfere with the polymerization of resin cement.

Glass ionomer cement was not used as the modulus of elasticity of glass ionomer is half that of zinc phosphate cement. Greater tensile stresses develop under crown and glass ionomer cements are more susceptible to elastic deformation,[56] there by having an effect on the remaining core and crown material, interfering with the results of the study as the core will not be subjected to a direct compressive load .

Samples were stored in 100% humid environment for 7 days at room temperature to simulate oral environment and were thermocycled. The specimens were thermo cycled 1000 times between 5°C and 55°C for 30 seconds in each temperature and with 15 seconds rest time. The teeth were thermocycled to simulate intraoral thermal stresses.

Specimens were mounted in a jig that allowed loading of palatal cusp in a axio-occlusal line at a 30-degree angle to the long axis of the tooth to simulate occlusal forces.

Continuous compressive speed of 2mm/min was applied by an Instron universal testing machine. Test conditions of this in vitro investigation differed from intraoral conditions. The Instron testing machine applied a continuous force from a single direction to a small point on the artificial crown of the restored tooth.

The force at which the tooth fractured in the 6 groups recorded in kgs and the results were statistically analyzed.

Of the 6 groups tested in the present study,group I(Intact teeth prepared for full cast metal coronal restoration)recorded 87.36 kg, group II(composite core) recorded 83.3 kg, group III (bonded amalgam core) recorded 77.30kg ,group IV(amalgam core) recorded 75.46 kg, group V (glass ionomer core) recorded 71.4kg,group VI (IRM) recorded 67.31kg.

In this present study group I (control) recorded the highest fracture resistance in kgs .Dentin provides the solid base required for tooth restoration. The structural strength of the tooth depends upon the sound dentin available to support and retain restorations (Nissan).

Group VI recorded the least fracture resistance.The compressive strength of IRM, used as provisional restoration is very less[57] .Leakage of IRM increased when subjected to thermal stress, which was attributed to its dimensional instability.[30]

Among the other experimental groups, group II (composite core) recorded the highest fracture resistance. The probable reason for the higher fracture resistance could be attributed to the modulus of elasticity. Composite materials have low modulus of elasticity (16.6 Gpa) compared to amalgam (27.6Gpa). A low-modulus material allows greater bending under load. When the strain exceeds the yield point, the material is irreversibly deformed,with some strain persisting even after the load is removed .The modulus of resilience is the quantity of energy that the material can absorb and still remain elastic.

When a structure comprised of dissimilar materials (such as the core material and the dentin) are stressed the material with higher modulus of elasticity deforms less. Composite core materials having modulus of elasticity values closely matching that of dentin is capable of withstanding the stresses by elastic deformation under simulated occlusal loadings. These findings are in accordance with a study done by Zidan et al[55] where restoring with composite is capable of recovering the tooth’s rigidity by 77.8% .In the same study composite was compared with bonded amalgam and amalgam restorations. The study concluded that bonded amalgam recovered 62.5% and with amalgam only 2.6% of stiffness was recovered.

The results of this present study is comparable to a study by Cloak et al[10] comparing the various core (composite,amalgam,glass ionomer)with prefabricated posts,where composite core presented higher fracture resistance. Another ex-vivo study evaluating the fracture toughness of various core materials showed high mean fracture toughness for composite core.[23]

According to Lee et al[23] toughening of a resin composite system was possible by crack pinning, crack branching by use of a large filler, and plastic deformation of the matrix around the filler. In addition to the above mentioned toughening mechanism, for high filler contents, numerous microcracks reduces the stress concentration at the crack tip and increases the fracture toughness. This phenomenon is called a microcrack-induced toughening effect.

When these microcracks are distributed broadly around the main crack, the crack tip extends by deflection from one direction to another and coalesces with microcracks, resulting in a very rough fracture surface. This phenomenon is called crack-deflection-induced toughening effect.

A resin coating on the particles would suggest that the adhesion between the filler and matrix was stronger than the actual resin matrix itself. This implies that the cracking process had been mainly in the matrix at short distances from the filler particles

The low fracture resistance of high copper amalgam could be due to the presence of an oxide or other contaminant on the particle surfaces would hinder the amalgamation with mercury to create isolated surfaces of weakness along which cracks can propagate preferentially at a lower energy requirement. Weak interfaces created by contaminants on alloy particle surfaces are most likely to be the inherent flaws by angular contraction porosity.[23]Another probable reason could be the higher value of modulus of elasticity when compared with composite.[40]

In the present study the fracture resistance values obtained using bonded amalgam and amalgam core were statistically insignificant. This results was in contrast to the study by Zidan Omar et al[55] where significant difference was found between stiffness of bonded amalgam and amalgam restorations. In the study by Zidan et al cast crown restoration was not done. So, in the present study the micro-environment of core-crown complex could have altered the biomechanics of these experimental groups.

Some studies found that bonded amalgam did not increase the fracture resistance of teeth. While amalgam bonding agents generally increase retention of amalgam to tooth structure, there are differences in retentive strength among the bonding agents.[3]

Among the experimental groups, group IV(glass ionomer) showed lower fracture resistance .Few studies(Cloak et al[10],Lee et al[23],Kovarik et al[22], Cohen et al[9]) also showed similar results.The reason for this could be that Glass ionomer cements when they are used as core materials lack inherent strength and were brittle.

Another probable reason by Lee et al[23], The use of Ketac Molar may be further restricted by an unattractive feature of extensive cracking upon drying, which is more clearly visible on the surfaces of recently set material. Such cracks could be flaws from which a fracture initiates.

A bonded composite would recover the maximum amount of the lost rigidity and should be considered as a first choice by the clinicians. If for some reason the clinician would choose amalgam, bonding amalgam could be expected to produce a stronger restoration that is less likely to fracture compared to a non-bonded amalgam restoration. In cases where large amounts of tooth structure is lost, bonding should be strongly advocated as a means to restore the lost rigidity and to prevent possible future tooth fracture. This approach might prove to be cost effective in the long run. However, long-term clinical data are needed to verify the longevity and the cost effectiveness of various core-build up materials.

In the present study teeth were mounted in a rigid block without the simulation of periodontal ligament which could evenly disperse stresses in the root .Further studies with more samples and simulating the oral environment needs to be carried out to extrapolate the results of the present study.

SUMMARY

This study was done to determine the fracture resistance of various core materials on endodontically treated maxillary first premolar. The core materials used were composite ,bonded amalgam, amalgam, glass ionomer .Natural intact tooth served as a positive control.

48 intact human,non carious ,human maxillary premolars were selected.Teeth were cleaned ultrasonically to remove the debris. The teeth were divided into 6 groups of 8teeth each. Teeth in the positive control group were prepared for receiving a full cast metal coronal restoration. In rest of the groups the teeth were endodontically treated, palatal wall removed 1mm from the CEJ, post space preparation done in the palatal root and prefabricated tapered threaded post luted using resin cement.Teeth were restored with different core materials.

The groups include:

Group II-Composite core

Group III-Bonded amalgam core

Group IV-Amalgam core

Group V-Glass ionomer core

Group VI-Intermediate restorative material (IRM) core

All the teeth were mounted in self-cure acrylic resin,2mm from the CEJ. Crown preparation was done such that 1mm of ferrule was obtained. Vinyl polysiloxane impressions were made. Cast crowns (Ni-Cr) were fabricated and zinc phosphate cement was used to lute these crowns

These samples were incubated and thermocycled. The samples were tested using Instron universal testing machine and the load was placed on the palatal cusp at 30 degree to long axis of the tooth with 2mm/min cross head speed.

The load at fracture was recorded as fracture resistance of the core in kgs. The results were analysed using One way Anova and Post Hoc Tukey test.

Based on the results obtained from this study, the maximum fracture resistance was recorded by the intact tooth.

Among the experimental groups group II (composite core) recorded the maximum fracture resistance. There was no significant difference statistically between the values of group III (bonded amalgam) and group IV (amalgam).IRM core recorded the least value among the experimental groups followed by glass ionomer core.

CONCLUSION

Within the limits of the present study the following observations were made

1. Fracture resistance of intact teeth prepared for full cast metal coronal restoration was the maximum

2. Among the experimental groups fracture resistance of the composite as core material was the maximum

3. The fracture resistance obtained by amalgam and bonded amalgam as core materials were not statistically significant

4. Among the experimental groups the fracture resistance of IRM core was the least followed by glass ionomer core (Ketac molar)

From the above findings it can be concluded that when light cured high strength posterior composite was used as core material in one walled and crowned endodontically treated maxillary premolar,the resistance to fracture to obliquely directed eccentric occlusal forces increased . The values of IRM suggests that it should be used only as a temporary restorative core build up material.

Further clinical studies under standard experimental conditions are needed in the science of core materials to increase the longevity of endodontically treated teeth.

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