ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 5, Issue – 2, April - 2022, Page No. : 28 - 36

Comparative evaluation of fracture resistance of three post endodontic restoration Amalgam, Composite, Cention N– An Invitro study

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Citation of this Article: Dr. Hema B.S., Dr.Riya Agrawal, Dr. Nishita Grandhi, Dr. Prachi Agrawal, Dr. Yash Chakkarwar,"Comparative evaluation of fracture resistance of three post endodontic restoration Amalgam, Composite, Cention N– An Invitro study", IJDSIR- April - 2022, Vol. – 5, Issue - 2, P. No. 28 – 36.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: Aim of the study was to compare and evaluate the fracture resistance of three types of post-endodontic restorations: Amalgam, Nanohybrid composite, and Cention N.

Methodology: 120 freshly extracted, intact, non carious, human, maxillary, premolar teeth with similar anatomic characteristics were selected. Mesial-occlusal-distal (MOD) cavities were prepared and teeth were divided into six experimental groups of 20 each and subjected to the following procedures: Group-I: intact teeth with no restoration (control); Group- II: standard endodontic access cavities were prepared; Group –III: unfilled teeth with prepared MOD cavity; Group –IV: teeth with MOD cavity restored with high copper amalgam; Group –V: teeth with MOD cavity restored with nano hybrid composite; Group –VI: teeth with MOD cavity restored with Cention-N. Root canal treatment was done for groups III, IV, V and VI after MOD cavity and before placement of the coronal filling. The specimens were mounted in a universal testing machine, and load was applied until the specimen fractured. The values were tabulated and statistical analysis by ANOVA and Post Hoc Turkey tests.

Results: The results showed that the maximum load required fracturing the test specimens of Group I was the highest, while it was lowest for Group III. significant difference was seen with different restorative materials.

Conclusion: Increased fracture resistance of restoration was demonstrated by Cention- N.

Keywords: Fracture Resistance, Dental Amalgam, Composite Resin, Cention –N, Endodontically Treated Teeth, Post Endodontic Restorations.

Introduction

The final stage in effective root canal therapy is to restore root canal-treated teeth with a permanent, definitive post endodontic restoration, as these teeth are more vulnerable to fracture. The dehydration and loss of dentin due to endodontic procedures, removal of important anatomic structures such as cusps, ridges, and the arched roof of the pulp chamber, all of which provide much of the necessary support for the natural tooth, have been cited as the most common reasons for fracture.[1]

Therefore, to ensure a successful outcome after endodontic treatment, adequate coronal seal plays a very crucial role. The prognosis of endodontically treated teeth is likely to increase if the material used to rebuild the tooth may strengthen its structural integrity. [2]

An ideal material used for restoration should be adhesive, tooth colored, resistant to wear, nontoxic, biocompatible to the tissue.[3]

For posterior teeth, amalgam is still considered one of the first choices of restorative material due to its strength and ability to withstand high masticatory load.[4] Due to microcrack propagation during fatigue loading; could reduce the fracture resistance of the remaining tooth structure.[5]

A new category of resin composites called Nano filled composites was introduced due to increase in the demand of a universal restorative substance for all sorts of direct restorations. However, these materials also do exhibit polymerization shrinkage to a certain extent.[6]

Recently, Cention N has been implemented in dentistry which the manufacturers claim to possess best of the properties of Amalgam and Glass ionomer cement. It's a "tooth-colored, alkasite-based basic filling material for direct restorations." It is self-curing and can be light-cured if desired. It also possesses a highly cross-linked polymer structure at a molecular level that contributes to its increased mechanical strength [7]

It possesses unique properties that in some way or the other reinforce the missing tooth structure. Hence the purpose of present in vitro study was to compare and evaluate the fracture resistance of three types of post-endodontic restorations: Amalgam, Nanohybrid composite, and Cention N.

Material and Method

120 freshly extracted human maxillary premolars with adequate root length and uniformity in size and shape were collected from Rishiraj College of Dental Sciences and Research Centre's department of oral surgery and were cleaned and stored in saline at room temperature. Samples were divided randomly into six groups of 20 teeth in each group. Freshly extracted teeth for the orthodontics, periodontal reasons within a 6 month of period were included. Teeth with root fracture, cracks, previous restorations, teeth in which root canal treatment had done, caries or defects in root portion, internal and external resorption, anatomical irregularities were excluded.

Samples were divided randomly into six groups of 20 teeth in each group.

Group I: Intact teeth.

Group II: Endodontic access cavities prepared.

Group III: MOD cavities were prepared; root canals were filled, with no restoration placed.

Airotor ISO14 Burs (Mani. Inc. Japan) were employed in the preparation of MOD (mesial-occlusal-distal) cavities. The proximal boxes were prepared to 2mm coronally from cemento-enamel junction.

Following access to the pulp chamber the root canals were identified and coronal preparation started with Gates-Glidden burs. A size 15 files (Mani. Inc. Japan) was then introduced into each canal until it was seen to protrude from the apex and the working length ascertained by subtracting 1mm from this measurement. The root canals were prepared to a file size 30 and stepped back with files 35 and 40 to produce an apical taper in completion of the preparation.The canals were dried with sterile paper points and coated with AH-plus sealer (Dentsply Int. Ltd. Maillefer, USA). A cold lateral condensation technique was used to obturate the teeth.This technique involved placement of a size 30 gutta-percha point at the full working length and additional accessory points. The coronal end of the filling was condensed into the root canal orifice and excess gutta-percha was removed at the base of the pulp using a hot plastic instrument.

Group IV: The teeth were prepared and the root canals were filled as in group III. Cavities were restored conventionally with high copper amalgam according to the manufacturer's instructions.

Group V: Teeth were prepared as group III and restored with Nanohybrid Composite. Before the composite restoration, the cavity were cleansed, etched (N-etch Ivoclar Vivadent) and a bonding agent was applied using a fifth-generation ethanol-based adhesive system (IvoclarVivadent), lightly air dried and light cured for 20 seconds. The composite restoration (Tetric N- ceram Ivoclar Vivadent) was then applied in the cavities in 2mm increments and light cured for 20 seconds each time. After removing the matrix, the restorations were shaped and polished.

Group VI: Teeth were prepared as group III and restored with Cention-N. The two components of the materials were used by mixing one scoop of powder with one drop of liquid on a paper pad using a plastic spatula until a homogenous mixture are formed. The restoration was placed in the cavity, after a setting time of 4 min, surface was polished using polishing discs (3 M ESPE, St. Paul, USA).

A thin coat of wax was applied on the external root surface of all the teeth. Stainless steel cylinder 2.5 cm diameter and 4.0 cm height was filled with self-cure acrylic resin and the teeth had been mounted 1mm apical to the cemento-enamel junction. After acrylic resin completely sets, then tooth was removed and wax was cleaned. Space on the mold was filled with poly vinyl siloxane impression material and teeth were put back into mould to stimulate periodontal ligament.

All the specimens were stored in 100 percent humidity for 24 hour before testing. The specimens were mounted in a universal testing at an angle of 45 degree to the long axis of the tooth. The load was applied to the occlusal inclines of the buccal and lingual cusps vertically down the long axis of tooth, at the crosshead speed of 1.0 mm per minute till the restoration were fractured.(Fig: 1)

Fig.1: Testing of the specimen for Fracture Resistance

The fracture resistance was recorded in Newton. Data obtained was statistical analyzed with ANOVA and Turkey tests.

Results / Discussion

The mean forces at fracture, minimum and maximum values and the SD for each group are presented in (Table 1).The mean forces at fracture were: group I (2150.6 N),group VI (856.48 N),group V (1190.6 N) ,group II (788.8 N) , group IV(540.7 N) and group III (290.2 N) respectively.

It can be observed that there was statistically significant difference in the mean fracture resistance between the groups with F value 184.82 and p value 0.001.(Table 2)

The result shows significant difference in fracture strength between groups which would require further analysis between each pair of groups with the help of Post hoc Tukey test.

Each pair of groups was further analyzed by using Post Hoc Tuckey which shows that each groups shows significant difference with all other groups.(Table 3)

The fracture strength of the groups is as follows

Group I>Group VI>Group V> Group II>Group IV> GroupIII

The highest fracture strength was shown by unaltered teeth. Among Restorations, Crown restored with Cention N showed the highest fracture strength followed by Nano Hybrid composite and least by High copper amalgam.

Table 1: Comparison of fracture resistance in root canal-treated teeth restored with different material

Group	Mean	SD	SE	Minimum	Maximum	Lower Bound	Upper Bound
Group 1	2150.6	366.7	82.0	1367.6	2989.2	1979.0	2322.3
Group 2	788.8	243.7	54.5	375.8	1205.8	674.8	902.9
Group 3	290.2	97.9	21.9	139.5	479.4	244.4	336.0
Group 4	540.7	133.9	30.0	319.2	756.4	477.5	602.9
Group 5	1190.6	219.6	49.1	679.9	1604.8	1087.8	1293.4
Group 6	1845.3	290.3	64.9	1367.3	2524.3	1709.4	1981.2

Table 2: Comparison of fracture resistance in Newton's between groups by one way Analysis of Variance (ANOVA)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	54527839.53	5	10905567.9	184.8	.001*
Within Groups	6726570.13	114	59005.0		
Total	61254409.67	119			

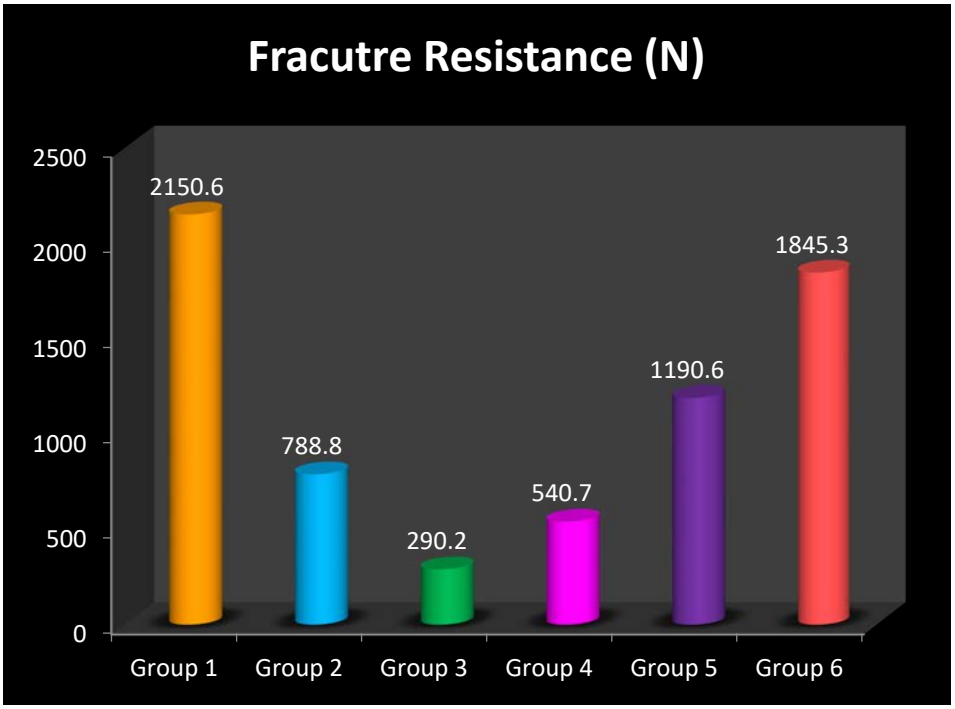
** Significant at 1% level of significance (p<0.01),

Table 3: Pair wise comparison of groups with fracture strength in Newton by using Post Hoc Tukey HSD test

Group	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Mean	2150.6	788.8	290.2	540.7	1190.6	1845.3
Group 1						
Group 2	.001**					
Group 3	.001**	.000**				
Group 4	.001**	.019*	.018*			
Group 5	.001**	.001**	.001**	.001**		
Group 6	.002**	.001**	.001**	.001**	.001**	

** Significant at 1% level of significance (p<0.01), *Significant at 5% level of significance (p<0.05),

Graph 1: Comparison of fracture resistance in root canal-treated teeth restored with different material



It has been shown that the weakening of teeth due to restorative and endodontic procedure increases with the reduction of tooth structure.[8] Loss of the marginal ridge has resulted in a 46% loss in tooth rigidity whereas an MOD preparation has resulted in a loss of 63 % relative cuspal rigidity.[9]

Literature reported that the mean fracture strength for unrestored teeth with MOD preparation was 50 percent less than that of unaltered premolar teeth. It was observed that cavity preparations made with occlusal opening and marginal ridge removal resulted in elevated strain values, supporting the fact that teeth are weakened by the removal of tooth structure. This highlights the importance of prevention and early diagnosis of carious lesions before they involve the marginal ridge.[10]

In our study, High Copper Amalgam, Nanohybrid Composite and Cention –N were used to restore endodontically treated maxillary premolars. Maxillary

premolars were selected because studies have shown that these teeth are more prone to fracture. Because of the anatomical shape of maxillary premolars that creates a tendency for the separation of their cusps during mastication.[11]

It has been noticed that difficulty in obtaining uniform fracture strengths for human teeth due to natural variations in tooth morphology. Maxillary premolars were selected as it is known that they show the least variations.[12]

Mesio-occlusal distal (MOD) cavities were prepared in our study , to simulate this preparation that is often found clinically and has been extensively reproduced in other clinical studies. The general effect of MOD cavity preparations is the creation of long cusps; thus, there is the need for a restorative material that not only replaces the lost tooth structure, but also increases the fracture resistance of the residual tooth and promotes effective marginal sealing.[13]

The force applied to the long axis of the tooth transmits the force uniformly.[14] In our study, the force was also vertically applied at a constant speed using universal testing machine.

The result of this investigation showed that the fracture strength in intact teeth (Mean value 2150.6 N) was significantly higher than other experimental group (Graph 1) due to presence of palatal and buccal cusps with intact mesial and distal marginal ridges, which form a continuous circles of dental structure, reinforcing the tooth.

In Group II- In which standard endodontic access opening were made showed the lesser fracture resistance (mean value 788.8) than intact teeth because endodontic procedures reduce the relative rigidity of the tooth by 5%, which is contributed entirely by access opening.

In Group III -MOD prepared unrestored teeth with endodontic treatment presented the least mean fracture resistance value (mean value 290.2) and highest percent of reduction in strength with significant difference when compared with the other group due to the type and quality of the remaining tooth structure especially the cusp and marginal ridges which form a circle of dentin and enamel which has an influence on fracture resistance.[15]This is in accordance with previous studies[16,17].

There was a statistically significant difference was noticed among different restorative material. High copper amalgam showed significantly lower fracture resistance than Nanohybrid composite and Cention -N with mean value of 540.7, 1190.6 & 1845.3 respectively. Amalgam has high compressive strength, but it does not bond to enamel and dentine may have less area of microcontact with the tooth structure. When a constant force is applied occlusally to the amalgam, it will distribute equally to all surfaces which are in contact. Therefore, under a constant force, the smaller the area of contact between Amalgam & tooth structure. The greater the pressure extends on the restorations, which eventually leads to fracture of the restorations. The presence of mercury and the types of interaction among its metal components make this material exhibit higher deformations level when submitted to occclusal loading. Maintaining the integrity at the margins of the amalgam restoration is a primary goal and breakdown in this area can lead to fracture and microleakage.[18,19] These findings are in accordance with previous studies[20, 21, 22].

Nanohybrid composite showed significantly higher fracture resistance than high copper Amalgam because nanohybrid composite based on nanofiller technology which enhances filler volume and increased fracture resistance and composite resin which forms

micromechanical bonding with tooth structure allows force to be equally distributed between the restoration and the tooth itself.[23]

However, Nanohybrid composite showed significantly lesser fracture resistance than cention-N the possible reason is this material undergoes is volumetric shrinkage during polymerization resulting in contraction stress, which may be the most critical factor in adhesion failure, as well as the creation of marginal gaps and secondary caries. Composite get cured enough in the deeper portion is area of concern as it can lead to decrease in marginal integrity and fracture resistance[24]

Specimens restored with Cention-N demonstrated the maximum fracture resistance followed by nanohybrid composite and Amalgam. The probable reason for Cention N alkasite cement to demonstrate highest fracture resistance lies in the fact that presence of barium aluminum silicate glass and calcium aluminum silicate glass fillers that render strength to the material.

Presences of stable self-cure initiator help in proper polymerization of restoration and there is a highly cross linked polymer structure which makes it more suitable and long lasting in stress bearing posterior region. The results obtained in this study are based on previous research.[25, 26, 27]

Within the limitations of this in vitro study, we can conclude that Cention-N demonstrated the greatest resistance to fracture in maxillary premolar; however these results must be interpreted with caution. Long term clinical observation of the material's performance any definitive should be studied to arrive at a conclusion.

Conclusion

On the basis of this study it can be concluded that the maximum load required to fracture the restoration was highest for Cention-N followed by Nanohybrid composite and lastly by high copper amalgam.

Further clinical studies are required to evaluate whether Cention-N reinforce the endodontically treated teeth as compared with other restorations.

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