ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
Index Copernicus Value: 68 . 16
PubMed - National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 5, Issue –2, April - 2020, Page No. : 01 - 06

Fracture Resistance of Mandibular Molars with Class 2 Preparation Restored With Cention N, Giomer and Amalgam: An In Vitro Study

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Citation this Article: Shilpa Shah, Nishtha Patel, Khyati Shah, Prerak Doshi, Krushnangi Yagnik, "Fracture Resistance of Mandibular Molars with Class 2 Preparation Restored With Cention N, Giomer and Amalgam: An In Vitro Study", IJMSIR- April - 2020, Vol – 5, Issue -2, P. No. 01 – 06.
Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Aim: Evaluation of the fracture resistance of mandibular molars restored with Cention N, Giomer and Amalgam in Class 2 cavity preparation.

Methodology: Forty freshly extracted intact, permanent mandibular molars were collected and mounted in acrylic resin blocks and randomly divided in 4 groups (n=10). Group 1 tested as unprepared positive controls, teeth in remaining all groups were prepared with class 2 cavities and filled with amalgam, giomer and cention n. All groups were stored in saline at 37^0C for 24 hours and thermocycled. Axial compression was performed in a universal testing machine using 8-mm metal sphere with a crosshead speed of 0.5mm/min. The results were analysed by Kruskal walls and Mann-Whitney U tests.

Results: Difference between fracture resistance of cention n and amalgam with unprepared positively controls was found statistically insignificant (P>0.05) where giomer is showing significantly lower fracture resistance than unprepared positive control.

Conclusion: Cention N have highest fracture resistance where Giomer showing inferior values of fracture resistance.

Keywords: Amalgam, Cention N, Giomer, Thermocycled.

Introduction

Depending on the extent of the cavity, restorative treatment is a predisposing factor for an incomplete tooth fracture. Removal of the tooth structure by cavity preparation has been shown to weaken the teeth and increase their susceptibility to fracture. In posterior tooth restorations, mechanical and physical properties play a vital role as it is subjected to heavy occlusal load. Posterior teeth, have an anatomic shape that makes them more likely to fracture the cusps and ridge due to deflection during mastication under occlusal

load. Commonest form of failure of posterior restoration is fracture of restoration.[1]

The basic purpose of the restorative materials is to substitute the biological, functional and esthetic properties of healthy tooth structure.[6] Fracture of restoration mainly occurs at the isthmus of a class 2 restored cavity due to stress concentration at the axio-pulpal line angle under masticatory load. Therefore, materials with high fracture resistance is highly recommended in such cases where it is subjected to heavy load as in case of class 2 carious teeth.[1] Fracture resistance depends on material's resistance to crack propagation from its internal defects. These cracks can result in microscopic fracture of the restoration margins or bulk fracture of the filling.[4]

In recent year, composite resins rivalled amalgam because of their esthetic properties and adhesiveness to tooth structure with good wear properties. Composite restorations are highly technique sensitive and need complete isolation, however it require less tooth structure loss hence become a routine procedure for class 1 and class 2 lesions. The choice of the right composite for each situation, use of a good procedure for bonding to the dental tissue and proper curing are essential. The major drawbacks of composite resins are polymerization shrinkage and secondary caries that may be difficult to diagnose.[3]

To overcome these disadvantages newer restorative materials are introduced which have superior esthetics, high radio opacity, high biocompatibility of composites; fluoride releasing capacity of glass ionomer cement along with high strength and durability of silver amalgam. Cention N is a basic, resin-based, alkaisite, self-curing filling material which can classified as a sub-category of composites.[1]

Materials & Methods

Forty freshly extracted intact, non-carious, calculus free human mandibular first molars were collected which was extracted for periodontal reasons. After removal of soft tissue remnant, teeth were stored in 1% Chloramine T solution for 3 days.[1,2]

To simulate periodontium, root surfaces were dipped into melted wax to a depth of 2mm below the cementoenamel junction (C.E.J.) to produce a 0.2-0.3mm thick layer around it, and then mounted in polyvinayl plastic cylinders with self-cure acryl 2mm below the C.E.J. after setting of wax. Each tooth was removed from the acrylic, and the wax spacer was removed from the root and acryl surfaces with hot water. Polyether (Impregum soft) was placed into the residual space, and teeth were reinserted into the cylinders. Thus, the periodontal ligament was simulated to some extent.[4]

Standardized class 2 cavity preparation were prepared in all the teeth using a No. 245 tungsten carbide bur with a high speed airotor hand piece under air and water spray. The size of the preparation was made proportional to the dimensions of the tooth to minimize variations resulting from tooth size.

Specimens were randomly divided into 4 groups.

- GROUP 1- Control group (intact teeth)
- GROUP 2- Restored with Amalgam (DPI Alloy)
- GROUP 3- Restored with Giomer (Shofu)
- GROUP 4- Restored with Cention N (Ivoclar Vivadent)

Group 1- teeth with control group were intact as a positive control. Group 2- teeth with amalgam group were restored with amalgam restoration. Amalgam was manipulated according to manufacturer's instructions. Group 3 and 4- cavity was etched by 37% phosphoric acid gel. The acid gel was placed on the enamel for 30

seconds etching time and dentin was conditioned for 15 seconds. Each cavity was then thoroughly rinsed with water for 20 seconds and dried with air, keeping the dentin surface moist. The adhesive was applied for 30 seconds, the solvent was gently air dried for 5 seconds and light curing was performed for 20 seconds.

In Group 3, Giomer was placed in the cavity in three horizontal layers. Each increment was light cured from the occlusal aspect for 20 seconds. In Group 4, Cention N was mixed according to manufacturer instructions and placed into cavity and cured for 20 seconds. To ensure adequate curing of Giomer and Cention N margins, both proximal surfaces were cured after removal of the matrix and excess material was removed using scalpel blades. Polishing procedures were performed immediately using Sof-Lex disks (3m ESPE).

Testing

The specimens were stored in distilled water at 37^0C for 24 hours. They were subjected to thermocycling treatment that comprised 500 cycles between 5^0C – 55^0C, with a dwell time of 20 seconds and transfer time of 5 seconds. After that the samples were subjected to fracture resistance using a universal testing machine. Axial compression was performed in a universal testing machine using 8mm metal sphere in contact with the occlusal surface with a crosshead speed of 0.5mm/min. fracture was recorded in kilograms (kg/f).

Statistical Analysis

The statistical analysis of force at fracture data was performed using nonparametric tests (Kruskal-Wallis and Mann-Whitney U tests). The Kruskal-Wallis nonparametric analysis of variance (ANOVA) test was used to test significance of difference between group variability. The level of significance was set at $P<0.05$. The Mann-Whitney U test was used to test significance of difference between each group. All analyses were performed using SPSS 20.

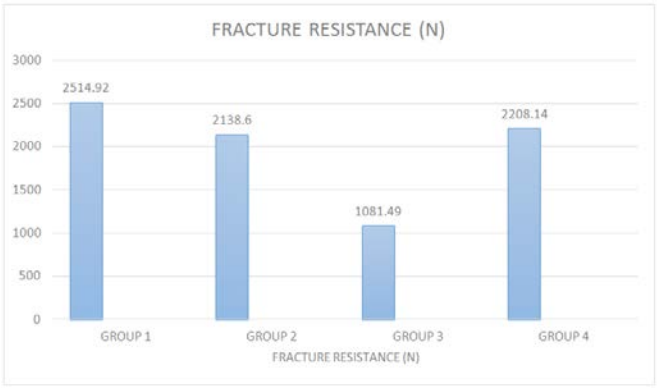
Results

The results of this study (Table 1) showed that Cention N material has the highest fracture resistance when compared to the other restorative materials. The results indicate that teeth restored with Giomer exhibited inferior numerical values of fracture resistance in relation to the groups restored with Amalgam and Cention N.

Table : 1

Groups	Mean (newton)	SD	Median	Lower 95% CI	Upper 95% CI
GROUP 1	2514.92	269.21	2520.58	1972.35	2905.30
GROUP 2	2138.60	384.79	2106.11	1389.33	2748.72
GROUP 3	1081.49	90.74	1041.67	1005.34	1298.12
GROUP 4	2208.14	105.61	2201.05	2069.89	2392.98

Graph 1



Discussion

Today every focus is on conserving the tooth structure using restorative materials, which adhere to tooth structure by minimal intervention, which can withstand the masticatory forces and are tooth colored to provide esthetic. Strong durable bond between dental biomaterials and tooth substrate are essential, not only from a mechanical stand point, but also from biological and esthetic perspectives.[9]

A fracture is a complete or incomplete break in a material resulting from the application of excessive

force. Fracture resistance is the inherent property of a materials by virtue of which it resists plastic deformation under a particular load and which is directly related to cracking. Masticatory forces on restored or unrestored teeth have a tendency to deflect the cusps under stress. Even through in vitro studies are not an actual reproduction of a typical chewing stroke, in that they apply a continuously increasing force until the tooth fracture, they represent an important source of information on the structural integrity of the tooth. Ideally any material that is used to restore missing tooth structure should reinforce the tooth and minimize risk of cuspal fracture.[1]

To more closely approximate the clinical situation when performing mechanical tests, certain factors (such as the root embedment method to simulate the periodontal membrane, the loading apparatus, and the mode of load transmission) must be considered. The simulation of the periodontal ligament should be done with an elastomeric material that is able to undergo elastic deformation and reproduce the accommodation of the tooth in the alveolus. This leads to no stress concentration in the cervical region of the tooth. In this experiment, a polyether impression material was used.[2]

As amalgam is strong in bulk section with higher durability so it can be used in various restorative needs. High-copper amalgams provide satisfactory performance for longer periods and do not appear to require polishing after placement.[3,5] It has slow setting process, mercury content and unpleasant color, were some of the reasons why alternative restorative materials were developed. The major disadvantage of amalgam, however, is it inability to bond to dental hard tissues and it is strong in only bulk section which features which necessitates the removal of more tooth structure and use of macro mechanical retentive features which cause further weakening of the remaining tooth structure. Conservative preparation design may affect fracture pattern and enhance options for subsequent restoration.[3]

The newer esthetics materials were introduced like Glass ionomer cements, Composites, Giomer, Compomer, Cention N with better biomechanical properties such as minimal destruction of tooth structure, better bonding to the tooth structure, better marginal seal, good esthetics, easy polishability, biocompatibility and compressive and tensile strength in evolution.[6]

Newer hybrid esthetic restorative material, Giomer was introduced with physical properties and biocompatibility of composite resin and added benefits of high fluoride release and antiplaque effect of Glass ionomer cement. Beautifil II, a type of Giomer, is based on pre-reacted filler technology, where pre-reacted glass particles are incorporated in the resin matrix to enhance its strength. Filler size of Giomer ranges between 0.01-5 µm, which is larger then the nano particles of composites. Larger particles tend to protrude futher through the surface and as such their cantilevel is longer, which leads to a higher angular moment, thereby causing earlier pulling out of the particles and giving less ewaqr resistance. According to Karim et al. due to the high filler content and without bonding of the resin with S-ORG filler it gives less strength and fracture resistance and high microleakage.[6]

Cention N is a basic, resin-based alkaisite, self-curing powder/liquid restorative material. Alkasite refers to a new category of filling material essentially a subgroup of the composite material class. The liquid comprises of dimethacrylates and initiators, whilst the powder contains various glass fillers, initiators and pigments. Patented alkaline filler increase the release of

hydroxide ions to regulate the pH value during acid attacks. As a result, demineralization can be prevented. It also acts as a shrinkage stress reliever minimising the shrinkage force and it is responsible for the high flexural strength. Moreover, the release of large numbers of fluoride and calcium ions forms a sound basis for the remineralization of dental enamel.[1]

Due to the sole use of cross-liking methacrylate monomers in combination with a stable, efficient self-cure initiator, Cention N exhibits a high polymer network density and degree of polymerization over the complete depth of the restoration.[8]

In this experiment, the authors used a steel sphere with a diameter of 8mm because it contacted the cusp in positions close to those found clinically and axial compression is given in a universal testing machine till the fracture of specimen which is recorded in kilograms (kg/f).

The limitations of this study must be recognized. The continually increasing load applied to the teeth in this investigation is not typical of the type of the loading that occurs clinically. During static loding, the force was applied slowly with a crosshead speed of 0.5mm/min. this corresponds to the load in a parafunctional situation rather than to an occlusal type load or an impact type load. Ideally, more relevant test methods should be developed in which the behaviour of the in vitro tests would more closely mimic the clinical condition.[2]

According to result Cention N and amalgam give highest fracture resistance which is statistically insignificant with fracture resistance of control group. But giomer showing statistically significant difference in fracture resistance.

Conclusion

In conclusion, within the limitation of this study, Cention N showed highest fracture resistance followed by Amalgam and Giomer is giving least fracture resistance in class 2 cavity in mandibular molars under compression loading.

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