IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 4 Ver.1 April. (2018), PP 52-56
www.iosrjournals.org

Comparative Evaluation of Fracture Resistance of Dental Amalgam, Z350 Composite Resin and Cention-N Restoration In Class II Cavity

Dr.Debolina Chowdhury[1], Dr.Chiranjan Guha[2], Dr.Priti Desai[3]
[1](Post Graduate Trainee, Department of Conservative Dentistry & Endodontics, Guru Nanak Institute of Dental Sciences & Research/ The West Bengal University of Health Sciences, India)
[2](Post graduate trainee, Department of Conservative Dentistry & Endodontics, Guru Nanak Institute of Dental Sciences & Research/ The West Bengal University of Health Sciences, India)
[3](Professor, Department of Conservative Dentistry & Endodontics, Guru Nanak Institute of Dental Sciences & Research/ The West Bengal University of Health Sciences, India)
Corresponding author: Dr.Debolina Chowdhury

Abstract: *Restoration after caries development in posterior teeth is generally done with different restorative material which includes metallic and non-metallic materials like amalgam, gold, composite resin, glass ionomer and ceramic. Amalgam has its own disadvantages of unaesthetic appearance toxicity and for which tooth coloured restorations emerged with better aesthetic properties. Gold on the other hand is expensive, technique sensitive and has unaestetic gold hue which is unfavourable for restorations despite better physical properties. In recent years with advancement in restorative materials composite resins have undergone several modifications to improve its restorative properties like aesthetic, physical and mechanical properties. Similarly glass ionomer cements are also modified to achieve better restorative properties to increases fracture resistance of tooth. Z350 nanofill composite resin is an advanced composite resin that can withstand such loads. Another new restorative material that is being launched for such class II cavity restorations is Cention-N that has the claim of higher fractural strength. This study aims at comparing the fracture resistance of two such advanced restorative materials, Z350 nanofill composite resin and Cention-N restorative material in a class II cavity with routinely used silver amalgam material.*

Keywords - *fracture resistance, Dental amalgam, Z350 composite resin, Cention-N, Class II cavity.*

Date of Submission: 23-03-2018 Date of acceptance: 07-04-2018

I. Introduction

Removal of tooth structure via cavity preparation has been shown to weaken teeth and increase their susceptibility to fracture [1, 2]. Depending on the extent of the cavity, restorative treatment is a predisposing factor for an incomplete or complete tooth fracture [3].

According to a study conducted by Joynt et al, in 1987 [4], preparation of an occlusal cavity reduces the tooth stiffness by 20%. If a marginal ridge is also involved and removed during this preparation the occlusal cavity transforms into a proximal cavity and the tooth stiffness further reduces by 2.5 folds resulting in an overall 46% reduction in tooth stiffness. If both marginal ridges are included in the cavity preparation design, the stiffness decreases by 63% [4, 5].

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. Restoration fracture mainly occurs at the isthmus of a class II 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 cases of class II carious teeth.

II. Material & Methods:

Forty freshly extracted intact, non-carious, calculus free human mandibular first molars were collected and mounted in self-cure acrylic resin blocks, with the crown uppermost and long axis vertical. The level of the resin was limited to 1.0 mm below the cemento - enamel junction.

Mesio-occlusal Class II cavity was prepared with standardized dimensions : 2 ± 0.2 mm pulpal width, 2 ± 0.2 mm gingival width, 3 ± 0.2 mm buccolingual width and are verified using a periodontal probe, with straight fissure and airotor bur.

The teeth were randomly divided into 1 Control group (intact teeth) and 3 experimental groups with 10 teeth each (n=10). Group 2 was class II cavity restored with amalgam, group 3 with Filtek Z350XT and group 4 with Cention-N restorative material.

All the teeth were thermocycled for 500 times ranging from temperature 5-55 degree celcius with 1 minute in each cycle. Fracture resistance was tested with a steel ball of 3mm diameter with a cross head speed of 1mm/min in Universal Testing Machine- Instron. Each tooth was subjected to vertical load on the occlusal surfaces till the restorations were fractured. The control group (intact teeth without any restoration) was also subjected to vertical load till the teeth fractured. The load was noted and recorded. The load at which the restorations fractured were noted and recorded and was statistically analysed.

III. Figures and tables:

fig.1: cavity preparation

fig.2: Universal Testing Machine- Instron

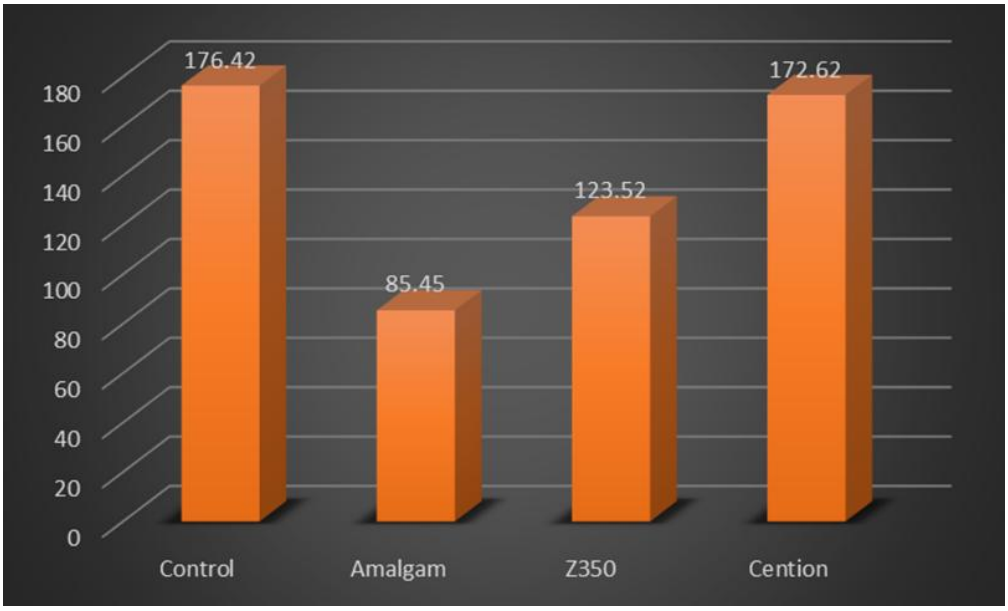
fig.3: testing tool with stainless steel ball head (3mm)

fig.4: testing of samples

Table 1:

Group	Mean fracture load (kg • f)	Standard deviation
1. Control (intact, unprepared and unrestored teeth)	176.42*	±17.92
3. Prepared and restored teeth with Amalgam	85.45*	± 4.53
4. Prepared and restored teeth with Z350	123.52*	±15.12
5. Prepared and restored teeth with Cention-N	172.62*	±11.66

Table 2:



IV. 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 amalgam exhibited inferior numerical values of fracture resistance in relation to the groups restored with Z350 composite.

Data was analyzed using one-way analysis of variance (ANOVA) test to access the difference between numerical groups. All statistical analyses were performed using SPSS 15 for Windows (SPSS Inc IL, USA) and Microsoft Excel, Office XP software (Microsoft Corporation IL, USA),

The mean fracture load (kg • f) for all groups revealed that there was a significant difference between all groups at $P < 0.001$. Additionally, there were significant differences in fracture resistance between the prepared, and those restored with Amalgam, Z350 composite or Cention-N restorative material ($P < 0.05$).

V. Discussion

A fracture is a complete or incomplete break in a material resulting from the application of excessive force. Fracture resistance is an important property directly related to cracking. Fracture resistance is the inherent property of a material by virtue of which it resists plastic deformation under a particular load. Masticatory forces on restored or unrestored teeth have a tendency to deflect the cusps under stress. Even though in vitro studies are not an actual reproduction of a typical chewing stroke, in that they apply a continuously increasing force until the tooth fractures, 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.

In this study, the difference in resistance to catastrophic fracture between the sound (unprepared) teeth and restored teeth was highly significant. This demonstrates the deleterious effect that cavity preparation has on the fracture resistance of posterior teeth.

Amalgam has traditionally been used as the best build-up material. As amalgam is strong in bulk section it can be used in various restorative needs, but its slow setting process, mercury content and unpleasant colour, were some of the reasons why alternative restorative materials were developed. The major disadvantage of amalgam, however, is its inability to bond to dental hard tissues which necessitates the use of macro mechanical retentive features which cause further weakening of the remaining tooth structure.

Since the introduction of composite resin restorative materials in the 1960, these widely used materials have been the subject of numerous studies to improve their properties. Composite resin restorations retained with an adhesive resin are the most popular restorations currently used. Composite resins have mechanical properties similar to dentin. Much attention has been focused on the polymerization shrinkage of these materials. If the polymerization shrinkage is great enough, the resulting stresses can compromise the union (chemical bonding and/or micromechanical interlocking) of the composite with the cavity surfaces of the tooth. If the polymerization stresses exceed the strength of the composite-tooth bond, bond breaking occurs and causes a gap to form between the tooth and the restoration. If the amount of polymerizing material in composite restorations could be reduced, the detrimental problem of polymerization shrinkage would be decreased. So various measures are taken in comparison of composite resin to reduce polymerisation shrinkage and addition of various types of fillers to increase strength.

3M™ ESPE™ Filtek™ Z350 XT Universal Restorative is a visible light-activated composite designed for use in anterior and posterior restorations. All shades are radiopaque. A dental adhesive, such as those manufactured by 3M ESPE, is used to permanently bond the restoration to the tooth structure. It has excellent polish, wide range of shades and opacities improved fluorescence unique nanofiller technology. Nanofillers allows increased filler volume and reduces polymerisation shrinkage.

Cention N (Ivoclar Vivadent) - The new filling material that belongs to the materials group of Alkasites that offers tooth-coloured esthetics together with high flexural strength. This patented alkaline filler increases the release of hydroxide ions to regulate the pH value during acid attacks. As a result, demineralization can be prevented. Moreover, the release of large numbers of fluoride and calcium ions forms a sound basis for the remineralization of dental enamel. The highly cross-linked polymer structure is responsible for the high flexural strength. The initiator system enables good chemical self-curing as well as light curing property thus enabling dual cure property.The liquid comprises dimethacrylates and initiators, whilst the powder contains various glass fillers, initiators and pigments. UDMA is the main component of the monomer matrix. It exhibits moderate viscosity and yields strong mechanical properties.

VI. Conclusion

In conclusion, within the limitation of this study, under compression loading, the use of Cention-N and Z350 restorative materials significantly strengthen teeth after Class II cavity preparation and restoration but dental amalgam showed comparatively inferior results.

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