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Research Article

COMPARATIVE EVALUATION OF THE FRACTURE RESISTANCE OF STANDARD AND MODIFIED MESIO - OCCLUSO - DISTAL CLASS II CAVITY DESIGNS WITH CENTION-N RESTORATION: AN INVITRO STUDY

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A B S T R A C T

Objectives: The main goal of this study was to assess the fracture resistance of standard and modified mesio - occluso - distal class II cavity designs with cention-N restoration.
Material And Method: Forty eight extracted teeth were randomly divided into 6 Groups of 8 teeth each. G1 consists of intact teeth. G2 was prepared with separate proximal boxes. The proximal preparation was standardized in all test groups. G3 was prepared with an occlusal extension that extend approximately one-third of buccolingual width and 2 mm in depth. G4 were prepared with the occlusal extension of 1mm in depth and width and with retention locks. G5: The occlusal extension was set as 1mm in depth and 2 mm in width and with retention locks. G6: The occlusalextension were having 2 mm in depth and 1 mm in width with retention lock. Samples were restored with Cention N and subjected to load to evaluate the fracture resistance.
Result: Fracture resistance of G4(2419.38N) and G5(1958.73N) was significantly greater than G3(1457.75N). Fracture resistance of G4(2419.38N) and G5(1958.73N) was significantly greater than G6(1664.78N).There was no significant difference between G3 and G6.All the three MOD modified groups with retention locks showed increased resistance to fracture than standard MOD group with no retention locks.
Conclusion: In modified MOD designs, resistance to fracture was increased when the cavity was prepared within the enamel and when retention locks were given compared to standard MOD deigns.

INTRODUCTION

Cavity geometry of the tooth preparation has been reported as a major factor in responsible for the ability of the tooth resistance to fracture.[1-4]Teeth with large cavity preparations have showed greater cuspal deflection than others with small cavity preparations.[3]

According to a study conducted by Joynt et al, in 1987,preparation of an occlusal cavity decreases the tooth stiffness by 20%. If a marginal ridge is also included and removed, the occlusal cavity transforms into a proximal cavity and the tooth stiffness further reduces by 2.5 folds reducing in an overall 46% in tooth toughness. If both marginal ridges are included in the cavity preparation design, the stiffness decreases by 63%.[5]Currently, composites are the most widely used materials in restorative dentistry.

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Dentists have pursued after a real alternative to amalgam or glass ionomer cements – a cost-effective, fluoride releasing product that is fast and easy to use without complex equipments and that suggest both strength and good esthetics.[6]

Cention-N is a basic filling material for direct restorations. It is dual cure tooth colored material. The Cention N thus renders the basic filling, combining bulk placement, ion release, and durability in a dual-curing, esthetic material - satisfying the demands of both dentists and patients.[7]

Commonest form of failure of posterior restoration is fracture of restoration. Restoration fracture usuallycomon at the isthmus of a class II restored cavity due to stress concentration at the axio-pulpal line angle under occlusal load.[5]

It has been reported that proximal retention locks in the axiofacial and axiolingual regions significantly strengthen the isthmus of a classII restoration and these locks are superior in increasing the restoration's fracture strength.[8]

MOD cavities where the occlusal extension in the enamel layer with retention locks have not been investigated in the literature

using Cention N. This study is designed to evaluate the fracture resistance of maxillary second premolar teeth with standard and modified conservative MOD cavity designs restored using Cention N where caries lesion does not extend beyond the dentinoenamel junction (DEJ) to mimic the clinical situations.

MATERIALS AND METHODS

After approval from the ethical committee group, tooth extracted for orthodontic treatment reason from Department of Oral and Maxillofacial surgery, KVGDC, Sullia were collected. The selected teeth were imbedded in auto-polymerized acrylic resin with a measurement of 2 mm below the cement-enamel junction (CEJ) were identified by a periodontal probe UNC-15 (UNC-15, Paterson Dental) for each tooth and marked with a permanent marker to simulate the biologic width of the natural teeth. After that, Wax up line(Modeling wax, BEGO) of 2mm height were performed on this marker, and used as a reference mark during embedment of the teeth in the acrylic resin.

Graphite pencil was used to draw the outline of the cavity before preparation. Enamel access preparation were performed with a 330-carbide bur(Prima Pear Bur FG-330). After that, a No. 245(Prima) Bur was used to complete the rest of the cavity preparation as follows where a high-speed handpiece will be operated with water coolant.

Teeth were randomly divided into 6 Groups of 8 teeth. G1 consists of intact teeth. G2 were prepared with separate proximal boxes that will be designed to be 1 mm approximately above the cemento-enamel junction from the cervical margins. The occlusaloutline of the proximal boxes were performed as approximately half of the intercuspal distance buccolingually and one-third of the mesiodistal dimension. The proximal preparation were standardized in all test groups. G3 werepreprepared with an occlusal extension that extend approximately one-third of buccolingual width and 2 mm in depth. G4 werepreprepared with the occlusal extension of 1mm in depth and width and with retention locks in the axiofacial and axiolingual line angles. G5: The occlusalextension were set as 1mm in depth and 2 mm in width and with retention locks in the axiofacial and axiolingual line angles. G6: The occlusalextension were having 2 mm in depth and 1 mm in width with retention lock.

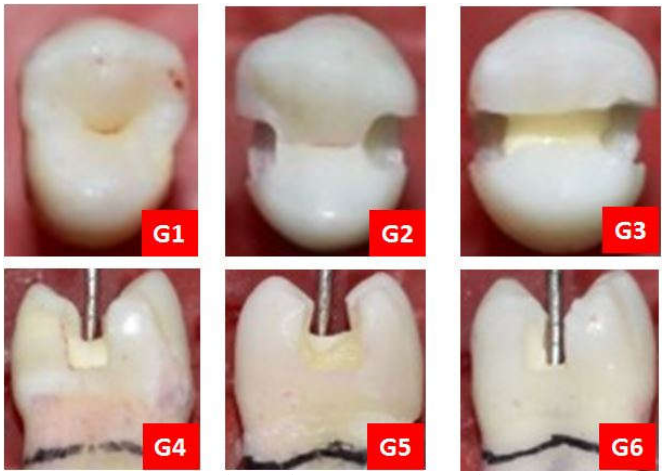

Figure 1 Images representing study groups; G1: Control group. G2: M and D cavities. G3: Standard MOD cavities. G4: MOD1 cavities. G5: MOD2 cavities. G6: MOD3 cavities

Samples were then restored with cention N using a plastic filling instrument and condensed with the help of a condenser and curing done for 20 seconds. Universal Testing Machine was used for assessing the fracture resistance at K.V.G. ENGINEERING COLLEGE, Sullia. A modified steel indenter with a diameter of 3 mm was customized to apply the compression load in Kg and converted into Newton. The load was being applied vertically until the sample fracture occurred. The load at the sample fracture was recorded and analyzed.

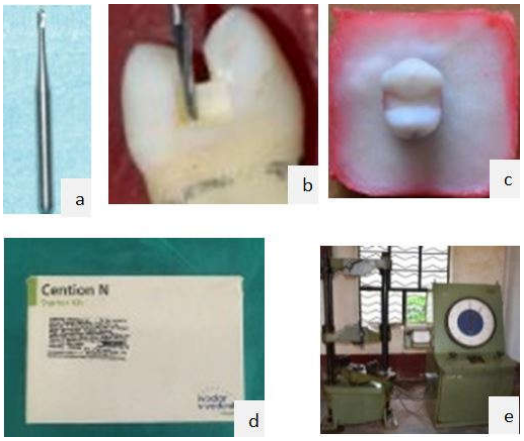

Figure 2 Cavity preparations and restoration materials; a: 330 bur. b: 169L Bur. c: Sample in acrylic resin. d. Cention N. e. Universal Testing Machine

Statistical Analysis

Statistical analysis was done using one- way ANOVA and Tukey HSD test. The results were presented into arithmetic mean and standard deviation. Analysis of variance (ANOVA) was applied to compare the mean effect. Tukey HSD testwas applied to compare differences between the means.

RESULT

Fracture resistance values in Newton (N) with mean of all groups were presented in Table 1. G1 showed the highest fracture resistance mean value (2898.4N) while G3 (standard MODs) had the lowest mean value (1457.7N). Furthermore, the results of this study showed that the fracture resistance of G4 and G5 (MOD1 and MOD2) was significantly higher than G3 (standard MOD), where in both groups, the preparation of the occlusal extension remained in the enamel. In addition, the fracture resistance of G4 and G5 (MOD1, MOD2) was significantly higher G6 (MOD3) where the preparation of the occlusal extension was 2 mm in the depth and the width Table 2. Proximal retention locks in the axiofacial and axiolingual line angles significantly increased the fracture resistance (Modified MOD groups with Retention Locks) when compared to Standard MOD groups.

Table 1 The fracture resistance values of all the groups (N=Newton)

SL NO	GP 1(N)	GP 2(N)	GP 3(N)	GP 4(N)	GP 5(N)	GP 6(N)
1	2744	2587.2	1401.4	2332.4	1911	1528.8
2	2930.2	2499	1450.4	2499	2009	1715
3	2989	2548	1528.8	2352	2038.4	1822.8
4	2812.6	2714.6	1548.4	2410.8	1842	1695.4
5	2842	2401	1519	2352	1911	1724.8
6	2891	2508.8	1568	2410.8	1940.4	1666
7	2959.8	2626.4	1421	2469.6	2009	1617
8	3018.4	2626.4	1225	2528.4	2009	1548.4
MEAN(N)	**2898.4**	**2564**	**1457.7**	**2419.4**	**1958.8**	**1664.8**

Table 2 The mean value and standard deviation of all the groups.

	N	Mean	Std. Deviation	Minimum	Maximum
1	8	2898.38	93.980	2744	3018
2	8	2563.93	96.439	2401	2715
3	8	1457.75	112.074	1225	1568
4	8	2419.38	73.231	2332	2528
5	8	1958.73	68.083	1842	2038
6	8	1664.78	97.359	1529	1823
Total	48	2160.49	521.608	1225	3018

However, there was no significant difference between G3 and G6 where both groups had the lowest fracture resistance means' values (1457.75 N and 1664.78 N), respectively, among all the groups.

DISCUSSION

This *in vitro* study was conducted to evaluate and compare the fracture resistance of standard and modified conservative MOD cavity designs to mimic the clinical situations. The result presented that as the progressive reduction of the tooth structure at the different groups increased as the fracture resistance decreased. This is in correlation with the previous studies. Furthermore, the results showed that MOD cavities with occlusal extension in the enamel layer had significantly higher fracture resistance than MOD cavities that extended beyond DEJ.

It is reported that proximal retention locks significantly strengthen the restoration's fracture strength.[8]Cention N belongs to the group of alkasites that offers tooth-coloured esthetics. This patented alkaline filler increases the release of hydroxide ions to regulate the pH value during acid attacks.
Hardness is defined as the resistance of a material to indentation or penetration. It has been used to predict the wear resistance of a material and its ability to abrade or be abraded by opposing tooth structures.[9]

According to Bozkurt *et al.,* the occlusal enamel thickness of premolar teeth ranged from 1.8 to 1.2 mm even with abrasion patterns after ultrasonic and histologic evaluations.[10]In this study, G4 and G5, where the occlusal cavity preparation did not extend beyond the DEJ (1 mm in depth), presented significantly higher fracture resistance as compared to G3 where the preparation violated the DEJ. In the meantime, G6, where the preparation depth was 2 mm and the width was 1 mm, it showed significantly lower fracture resistance as compared to G4 and G5. Furthermore, there was no significant difference between G6 and G3 (standard MOD) which might be due to the violation of DEJ. All the modified MOD groups showed inc1reased resistance to fracture which implies that retention locks significantly increased the fracture resistance
Mondelli *et al* found that MOD cavity had the lowest fracture resistance value as compared to Classes I and II two surfaces, especially when the one-third of the interocclusal distance was prepared. They considered that the isthmus width was the impact factor that affected the fracture resistance of different groups.[11]

According to a comparative study conducted by *Paromita et al.* Cention N showed the highest hardness values when compared with restorative materials such as nanohybrid composite resin, silver amalgam and type II GIC. Probably their increased microhardness is related to the nanoparticle size of inorganic filling.[12]

In another comparative fracture evaluating study conducted by *Debolina et al*. under compression loading, the use of Cention-N material significantly strengthen teeth after Class II cavity preparation and restoration but dental amalgam showed comparatively inferior results.[5]

Cention N is a UDMA based, self curing powder/liquid restorative with optional additional light-curing. The liquid comprises of dimethacrylates and initiators, whilst the powder contains various glass fillers, initiators and pigments.[13]In this study, since Cention N is a dual cured restorative material, light curing was done for 20 seconds.

Limitations of the present study included that although this *in vitro* investigation was attempted to mimic clinical situations, it was with the limited presentation of actual oral cavity environment where multiple factors may affect the end result such as pH, saliva, oral temperature, and occlusal loading. Moreover, the MOD cavities in the present study were designed with specific dimensions, which in the actual clinical scenario controlled by the extent of caries lesions.

CONCLUSION

Within the limitations of this study, In modified MOD designs, resistance to fracture was increased when the cavity was prepared within the enamel and when retention locks were given compared to standard MOD deigns.

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