Original Research Article

Evaluation of compressive load required to fracture premolar restored with different restorative materials-an in vitro

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ABSTRACT

Background: *Restored teeth are generally weaker than sound teeth due to loss of tooth structure caused by caries and restorative procedures. The loss of both tooth structures as a result treatment will increase the likelihood of fractures during functional loading.*

Objective: *To evaluate the fracture resistance of premolars with class II disto occlusal preparations restored with light cured composite with light cured composites layered incrementally and silver amalgam in comparison with intact and unrestored teeth.*

Material and methods: *50 freshly extracted premolars were randomly divided into 5 groups of 10 teeth each. All the 50 specimens were then subjected to a compressive load in a Universal Testing Machine (Hounsfield). The loads required to fracture the teeth were recorded and the data, obtained were subjected to statistical analysis and the following results were arrived.*

Result: *Teeth restored with light cured composite incrementally placed in oblique layers produced a higher fracture resistance than any other group and showed the closest value to the intact teeth. This was followed in descending order by light, cured composite placed in horizontal increments and silver amalgam.*

Conclusion: *Result concluded that teeth restored with light cured composite incrementally placed in oblique layers produced a higher fracture resistance than any other group and showed the closest value to the intact teeth.*

Key words: *light cured composite, silver amalgam, oblique technique, horizontal technique*

Introduction

For several years clinicians have known the importance of a conservative approach to cavity preparation with the view to maintain the strength of the tooth and to reduce the incidence of fracture.[1,2,3,4] Recent studies have focused on several concerns related to weakening of the teeth following class II preparations and the effect of restorations in strengthening the remnant tissue. It has been claimed that the strength of a tooth decreases in proportion to the amount of tooth tissue removed, particularly in relation to the width of the occlusal section of the preparation. In spite of the problems related to the application of direct composites in posterior teeth, it has been demonstrated that the development of restorative systems has contributed to the longevity of restored teeth. [1, 3] Teeth weakened by restorative procedures should be reinforced by restorative materials to strengthen the remaining tooth structure. Amalgam does not bind the walls of the cusps together and does not strengthen the remaining tooth. [2,5,6] The advantages of bonded restoration are the conservation of tooth structure as well as tooth reinforcement. Resin bonded restorations replace the tooth's rigidity which is lost after cavity preparation, and provide splinting of cusp.[7,8,9] The clinical presentation of newer dental composites has been significantly improved over the past decade by incorporation of high concentrations of finely ground fillers to provide adequate strength and excellent wear resistance.

Materials and Methods

The study was conducted in the Dept. of Conservative Dentistry & Endodontics, Yashwantrao Chavan Dental College and Hospital, Ahmednagar. Fifty non-carious, unrestored human maxillary premolar teeth extracted for orthodontic treatment were used as test specimens.

Preparation of sample: Each of these test samples was mounted in a base of acrylic resin exposing only the crown portion. They were randomly divided into 5 groups of 10 teeth in each group and colour coded for identification. Standardized class II disto-occlusal cavities were prepared on specimens of Group 2 to Group 5 and then restored with the following restorative materials.

Group 1- Sound, unprepared teeth.
Group 2- Cavity prepared but unrestored
Group 3- Cavity prepared and restored with light cured composite incrementally placed in horizontal layers.
Group 4- Cavity prepared and restored with light cured composite incrementally placed in alternating oblique layers.
Group 5- Cavity prepared and restored with high copper silver amalgam.

In group 3 after etching a layer of dentin bonding agent was applied to the cavity and light cured for 20 seconds. A transparent celluloid matrix strip with a transparent matrix holder was applied and nearly half the volume of the cavity was filled with composite resin placed in several horizontal layers and incrementally cured the composite restorative material. The displaced composite restorative material was cut and removed. The restoration was then light cured for 40 seconds and the handle of the insert was cut and removed. The excess composite was contoured and finished to give a smooth surface. In Group 4, composite resin was placed after etching and application of bonding agent in alternate oblique layers and incrementally cured and finished as described for Group 3. In Group 5, the teeth were restored with high copper silver amalgam and polished after 24 hours.

Fracture resistance Test

Each of the colour coded samples was then mounted to the lower member of universal testing machine. A compressive load of a cross-head speed of 0.1mm per second (0.23 inch/min) to the point of fracture. The maximum force required to fracture each sample was recorded in kilograms. [Fig. 1]

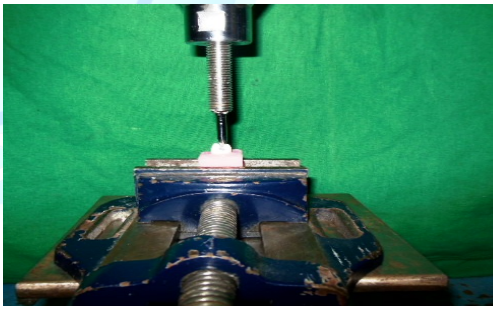

Fig. 1 Universal Testing Machine

Statistical analysis was performed using One- way ANOVA to compare the mean compressive load in five different study groups.

Results

Mean and standard deviation values of forces required for fracturing the roots of the tested Groups are expressed in kilograms and the results are presented in [Table 1]. The mean compressive load in

Group 1 (136.16) was significantly higher than Groups 2, 3, 4 and 5 (P<0.05). Similarly the mean compressive load in Group 4 (109.11) was significantly higher than Groups 2,3 & 5 (P<0.05). Also, the mean compressive load in Group 3(100.80) and Group 5(67.24) was significantly higher than Group 2 (56.42) P<0.05 was considered as the level of significance. Statistical analysis was performed using one way analysis of variance (one-way ANOVA) to determine significance differences among groups. [Table 3]

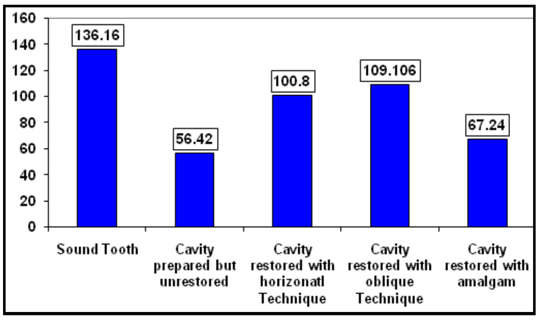

Fig. 2 Compressive load of all groups

Table 1: Mean and standered deviation of fracture resistance

Test group	Mean±SD
Group 1	136.16±27.83
Group 2	56.42±20.77
Group 3	100.80±43.26
Group 4	109.11±17.19
Group 5	67.24±25.49

Table 3: Result of one-way ANOVA to compare the mean compressive load in five different study groups

Sources of variation	Df	Sum of squares	Mean sum of squares	F.ratio	P value
Between group	4	20901.18	5225.295	6.4944	0.00161
Within group	45	3620.83	804.574		
Total	49	57107.01			

Prepared but unrestored teeth (Group 2) showed the least mean compressive load (56.42) as compared to intact teeth (136.16). In this study it was observed that obliquely placed composite resin group showed much higher values (113.10) than the composite-resin placed in horizontal increments (100.8). Composite resin placed in oblique increments produced an interlocking and contributed to the overall strength of the restoration. It also helped to bind the walls of the prepared cavity and reinforced the tooth better.

Discussion

For several years clinicians have recognized the importance of a conservative approach to cavity preparation with the view to maintain the strength of the tooth and to reduce the incidence of fracture. Teeth weakened by restorative procedures should be reinforced by restorative materials to strengthen the remaining tooth structure. Amalgam does not bind the walls of the cusps together and does not strengthen the remaining tooth. [5]

A restored tooth tends to transfer stress differently than an intact tooth. Any force on the restoration produces compression, tension or shear along the tooth/ restoration interface. Since enamel is no longer continuous, its resistance is much lower. Therefore, most restorations are designed to distribute stresses onto sound dentin, rather than to enamel. Once in dentin, the stresses are resolved in a manner similar to a normal tooth. This study was designed to evaluate the fracture resistance of teeth of 5 groups of samples. Prepared but unrestored teeth showed the least mean compressive load (56.42) as compared to intact teeth (136.16). In this study it was observed that obliquely placed composite resin group showed much higher values (113.10) than the composite-resin placed in horizontal increments (100.8). Composite resin placed in oblique increments produced an interlocking and contributed to the overall strength of the restoration. It also helped to bind the walls of the prepared cavity and reinforced the tooth better. This concurs with the findings of Me Culloc, [10,11] Markley, [12] Wieczkowski, [13] Jagdish [14] and vand Jensen. [15] They reported that oblique placement technique could significantly reduce the degree of cuspal fracture. As regards fracture resistance it was shown in this study that horizontal incremental layering of composite resin (100.8) was superior to amalgam restoration (67.24). Incrementally placed composite resins showed much greater fracture resistance than silver amalgam restorations. This study investigated the role of these restorative materials in matching the strength of remaining tooth structure. It was observed that composite resin placed in oblique increments resisted the tooth better against fracture. This indicates that these resins could reinforce the tooth structure better. The advent of composite resins brought about several advantages such as tooth reinforcement and improved bonding. This study indicated that light cured posterior composites placed in oblique increments helped to match the strength of remaining tooth structure and was the only group, which showed nearest value to the unprepared teeth.

This study concludes that teeth restored with light cured composite incrementally placed in oblique layers produced a higher fracture resistance. This was followed in descending order by light cured composite placed in horizontal increments and silver amalgam. In class II restorative material, composite resin placed in horizontal increments exhibited greater fracture resistance than silver amalgam. The clinician should know that the advantages of bonded restoration are the conservation of tooth structure as well as tooth reinforcement. Resin bonded restorations replace the tooth rigidity which is lost after cavity preparation.

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