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Original Article

Resistance to Tooth Fracture with Different Restorative Material

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***ABSTRACT*:**
Background: Dental caries causes irreversible damage to the tooth. Different restorative materials are used to restore the tooth. **Aim**: To evaluate the resistance to tooth fracture with different restorative material cast gold, silver amalgam and composite.**Material & method**: An in vitro study was carried out on thirty two freshly extracted human mandibular first molar to investigate the effect of different restorative materials on the resistance of remaining tooth structure to fracture.The amount of load required to fracture the experimental sample was assessed against the control sample using Hounsfield tensometer.**Result**: Cast gold offers maximum resistance and silver amalgam provides least resistance. **Conclusion**: All restorative materials included in this study exhibited some degree of resistance to tooth fracture. Cast gold offers maximum resistance in comparison to unrestored specimens and those restored with either silver amalgam or composite. Composite fall in between cast gold and amalgam restoration.
Keywords: Tensometer, Cast gold, Amalgam , Composite

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INTRODUCTION:

Many significant developments have taken place in dental practice in the last decennia. Some of these changes specially in the field of preventive dentistry and dental material science have had an important influence on the indication of the restorative procedures.

Dental caries causes irreversible damage to the tooth structure. The curative treatment of already established dental caries is practically limited to restorative materials. The caries defects should be restored in a relatively short period of time at a low cost to the patient by means of plastic restorative materials such as amalgam and composites. Introduction of pins and etching techniques have extended the range of application of these materials. Also

Introduction of cast gold restoration makes it possible to protect the tooth against possible fracture and to stabilize the occlusion.

Sound teeth are rarely fractured from the stresses of mastication because the anatomic form of posterior teeth with cusp and fossa presents a design that possesses a tendency to deflect the cusp under stress. Fracture of a cusp may occur in teeth which have been weakened by caries and by the cavity preparation required for restoration.

- The masticatory forces in the molar region may range from 41 kgm to 91 kgm and in premolar region from 23 to 46 kgm. Enamel is a brittle substance and has a low modulus of resilience than the dentin. Therefore, unless it is supported by dentin which has the ability to deform elastically, it fractures under normal masticatory forces.
- Failure of dental restorations is a major concern in the field of restorative dentistry. The most common causes are improper cavity preparation and improper manipulation of restorative materials.
- Some attempts have been made to assess the relationship between the size of cavity and weakening effect on the remaining tooth structure, so that the newer concept of occlusal cavity preparation stresses a one-fourth intercuspal width

as compared with one-third or more in G. V. Black type of preparations. This produces considerably greater facial and lingual cusp strength which does not significantly weaken the tooth structure.

- Investigations in vitro have determined that posterior teeth are severely weakened by an MOD[1] preparation because of greater loss of tooth structure.
- The present study is designed to determine the effect of different restorative materials on the resistance of remaining tooth structure to fracture.

MATERIAL AND METHODS

The present study was carried out in vitro on thirty-two freshly extracted human mandibular 1st molar in the Department of oral pathology, Sarjug Dental College & Hospital, Darbhanga. The samples were obtained from the Department of oral surgery and were thoroughly cleaned and washed under running tap water with a camel hair brush to remove blood, saliva and debris. Calculus if present, was removed with hand scaler. The samples were then stored in normal saline for further experimentation at room temperature.

For the proposed study, the samples were divided into two groups (1) Control group(2) Experimental group.

The control group comprised of 8 teeth, where as experimental group was divided into three sub-groups of 8 teeth each on the basis of the restorative materials (Table 1)

- Preparation of specimens- Teeth were mounted in box shaped quick
- Setting acrylic resin blocks. After polymerization these blocks were finished. Thereafter the entire procedure was divided into three steps.

Step -1: Cavity Preparation- A standard M.O.D. cavity was prepared for control group as well as experimental sub-groups, except sub group c in which modifications were carried as per standard cavity for gold inlay.

Step-2: Restoration of the samples with different materials

Sub-group A (silver amalgam restoration)-A matrix band was applied to the tooth.

Fine grain silver alloy after manipulation according to manufacturer's instructions, was carried into the cavity and condensed. Carving was done to simulate the anatomy of the mandibular first molar. Samples were again stored in normal saline at room temperature. Finishing and polishing was done after 24 hours and samples were again stored in normal saline for 48 hours.

Sub-group B (Composite resin restoration)-A transparent celluloid matrix strip with a transparent matrix holder was applied. Composite resin was placed after etching and application of bonding agent in alternate oblique layers and incrementally cured. Subsequently the filling was finished and polished, lubricated with Vaseline and the samples were stored in normal saline for 48 hours.

Sub- group C (cast gold restoration)-Petroleum jelly as separating medium was applied in the prepared cavity. Then the direct wax pattern was made and invested. Casting was carried out in cast gold (22 carat).The casting obtained was further subjected to pickling. The inlay was fitted in the cavity and sprue was cut. Finishing and polishing was done and specimens were stored in normal saline for 48 hours.

Step-3: The samples of control and experimental groups were examined under stereoscopic microscope to rule out the possibility of fracture line prior to fracture of teeth. Then the samples were subjected to a compressive load in a Hounsfield tensometer at a very slow speed. A steel ball of 5mm diameter was selected to apply the load and was allowed to seek its most stable position at the central fossa of restoration. The load was gradually increased till the fracture of tooth, which was recorded in kgfand was statistically analyzed.

RESULTS

The results are presented in Table I, 2, 3 and 4. Table 1 depicts the amount of load required to fracture samples restored with different restorative materials. Specimens of the control group show minimum load as compared to those of the experimental samples .Sub-group B displays a greater fracture load than sub-group A, whereas sub-group c depicts further increase in load than sub-group B.Table 2 represents the statistical load analysis of fractures in various groups. The control group indicated a mean load of only 185 kgf. (S.D. 15.35).of the various experimental sub-groups, sub group C, exhibits the maximum mean load (353.1 kgf.) followed closely by sub-group B (315.6 kgf). Sub-group A, reveals the least mean load of 290 kgf with standard deviation of 13.62. A comparison of the various experimental groups with control is illustrated in Table 3. It can be observed that load shown by all the sub-groups, are greater at a very high level of significance ($p < 0.001$ for all sub-groups). Table 4 presents the results of comparison of the various experimental sub-groups with each other, with respect to amount of load required to fracture a tooth.Thus from the above data, it is apparent that although, all materials provide varying degrees of resistance to tooth fracture, cast gold offers the maximum resistance when compared to control and also to other experimental sub-groups. This is followed closely by composites. Silver amalgam provides least resistance among the experimental groups.

DISCUSSION

Any discussion on cavity preparation demands a terminology and reference to black, G.V[2]. He was the first to publicize an acceptable systemic method of cavity preparation and also a classification of cavities. His work still forms the basis of our cavity preparation to date but of course many modifications have been introduced.

Table 1:Specimens showing the fracture loads in Kgf.

S.No.	Group	Load required by samples to fracture							
		SAMPLES							
		1	2	3	4	5	6	7	8
1.	Control Group	180	200	160	180	210	190	185	175
2.	Experimental Group								
	(a)Sub Group 'A'	280	290	275	300	285	310	275	305
	(b)Sub Group 'B'	300	340	290	315	295	325	310	350
	(c)Sub Group 'C'	340	365	380	325	315	350	380	370

Table 2: Statistical evaluation of Fracture Load in Various Group

Groups	Mean	Standard Deviation (S.D.)	Standard Error of Mean(SEM)	Coefficient of Variability (%) (C.V.)
Control Group	185.0	15.35	5.43	3.30
Experimental Group				
(a)Sub Group 'A'	290.0	13.62	4.84	4.70
(b)Sub Group 'B'	315.6	21.45	7.58	6.80
(c)Sub Group 'C'	353.1	24.77	8.76	7.02

Table 3: Comparison of various experimental groups with control sample

S.No.	Groups	Control group		Experimental group		't'
		$Mean_1$	$S.D_1$	$Mean_2$	$S.D_2$	Value
1.	Control Vs. Sub Group 'A'	185.0	15.35	290.0	13.62	14.5***
2.	Control Vs. Sub Group 'B'	185.0	15.35	315.6	21.45	13.9***
3.	Control Vs. Sub Group 'C'	185.0	15.35	353.1	24.77	16.3***

*** = Very highly significant (P < 0.001)

Table 4:Comparison of various experimental sub-groups with each other

S.No.	Groups of Sub-Groups	First Sub- group		Second Sub- group		't'
		Mean	S.D	Mean	S.D	Value
1.	Sub Group 'A' Vs. Sub Group 'B'	290.0	13.62	315.6	21.45	2.8*
2.	Sub Group 'A' Vs. Sub Group 'C'	290.0	13.62	353.1	24.77	6.3***
3.	Sub Group 'B' Vs. Sub Group 'C'	315.6	21.45	353.1	24.77	3.2**

It is the strength of the eventual whole, restored tooth which is important and a breakdown of either the material of restoration or the remaining tooth is equally a failure[3]. Some attempts to assess the relationship between the size of the cavity and the weakening effect on the remaining tooth have therefore, been made (Vale,1956)[4].Numerous in vitro investigations have determined that posterior teeth are severely weakened by an MOD preparation with a width of one-third the intercuspal distance or greater. The present study was thus designed to compare the effect of amalgam, composite and cast gold on the resistance of remaining tooth structure to fracture.

The samples for the present study consisted of freshly extracted human posterior teeth because these have a vital role in mastication and are the most common victim of caries. Mandibular first molars were chosen to standardize the procedure. The amalgam, composite and cast gold,because of their superior physical properties were used in the present study.In the present study, where significant difference could be detected in strength of teeth restored with silver amalgam or gold inlay as compared to the strength of teeth left unfilled is in disagreement with the Vale's[5] original work with bicuspids, where no significant difference could be detected between strength of teeth

restored with silver or inlay, and strength of teeth which were left unfilled. This may be explained on the basis of geometry of load application. Vale's[5] study utilized only bicuspids where the steeper inclination of cuspal planes assures that the ball will contact the tooth on enamel regardless of whether the tooth is restored or unrestored. In the present study where the samples consisted exclusively of molars the greater dimension and shallower inclination of cuspal planes result in a transition from enamel contact to contact with restorative material.

The result of present study illustrated that as compared to amalgam, composite provides much resistance to tooth against fracture. This view is corroborated by Mishelly[6] who advocated the use of composite resin in MOD, when compared to amalgam restoration.

The finding of the present investigation regarding the composite restoration and amalgam restoration(t=2.8 and 1/4<0.05)are in support of opinion of share J[6] .in that composite offers more resistance to remaining tooth structure to fracture as compared to amalgam. This may be explained on the basis of varying compressive strengths of the two materials. Composite possessing a higher compressive strength has the ability to absorb stresses to a greater extent thereby reducing the transfer of stresses to the tooth material. A perusal of literature reveals no study where the comparison between the cast gold restoration and the composite was considered. However, in the present study on comparison ` t` value was determined to be 3.2 ($p<0.01$) which is highly significant statistically. On this basis it can be stated that cast gold offers more resistance to remaining tooth structure as compared to composite.

From the results of the present study it can be deduced that the use of amalgam [6]as restorative material in contrast to unrestored tooth provides greater resistance. The same material however, exhibits least resistance when compared with cast gold and composite. Cast gold provides maximum resistance to tooth fracture when compared to control as well as to the experimental groups. Composite fall in between cast and amalgam.

Since directly related studies could not be found in the available literature a comparative evaluation of the results of the present study could not be carried out. A few studies are nevertheless available(Vale,1956; Re, G.J[9].,1981; Paul k. Blaser[8],1983; Almquist[7],1983;) that have investigated the effect of restorative materials on the resistance of remaining tooth structure to fracture, but their emphasis has been either on design of class II ,or the size of restorations. It is therefore, suggested that this aspect be further investigated using a larger sample.

CONCLUSION

Clinical evaluation of the experimental results must be made guardedly for, the complex modes of load application encountered in normal and abnormal working occlusion are difficult to mimic experimentally. No experimental method truly simulates the conditions under which the teeth function in the oral environment.

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