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Original Article

Effect of Different Veneer Designs on the Strength of Composite Veneers

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Abstract

Aim: The aim of this *in vitro* study was to evaluate the different designs of composite veneers and their relative strength.

Material and Methods: Thirty extracted, intact, human maxillary central incisors were selected and prepared with three different veneer designs: (1) Feather preparation, (2) bevel preparation, and (3) incisal overlap-palatal chamfer. Restoration was done with composite veneers and failure was recorded at the incisal, gingival, or at both sites after applying appropriate load.

Results: Composite veneers with incisal overlap-palatal chamfer showed highest fracture resistance among the three designs. The mean (SD) fracture loads were as follows: Group 1: 100.4 N, Group 2: 105.3 6.9 N, and Group 3: 123.0 N. The most common mode of failure was debonding for veneers with feather preparation and fracture when incisal edge is reduced. The most frequent localization of fracture was incisal.

Conclusion: The type of preparation has a significant effect on fracture load for composite veneers. This study indicates that using an incisal overlap-palatal chamfer preparation design significantly increases the fracture resistance compared to feather and bevel preparation designs.

Key words: Composite veneers, Fracture resistance, Preparation design

INTRODUCTION

Esthetics, particularly esthetics of the teeth, has become one of the prime areas of concern for the patient in the current times. Now, esthetic issues, such as discolored, broken, chipped teeth, and midline diastemas, can be corrected easily with the advances in technology and materials.[1,2] Composite veneers are one of the best methods to do as they require a simple technology and provide high esthetics. Their high mechanical resistance, low allergy-causing potential, effective cost, and opportunity for clinical repairs increase the use of composite veneers in clinical practice as a contemporary esthetic solution.[3] Therefore, it is necessary to decide the best preparation design for optimum performance. Ideally, the bond should be completely in enamel with the preparation of labial and proximal surface being 0.3 mm–0.5 mm.[4] The preparation's margins must be chamfered. Four possible designs of preparation have been indicated: Window preparation (non-reduced incisal edge); feather preparation (non-reduced incisal edge with the entire labial surface covered by the veneer); bevel preparation (reduced incisal edge with buccopalatal tilt preparation over the entire tooth width); and incisal overlap or palatal chamfer (the reduction of incisal edge with palatal extension preparation). Before starting the preparation, it is important to decide whether to reduce the incisal edge or not. Indirect technique is used to fabricate a restoration in a dental laboratory. Bonding of composite veneers to the teeth is done by adhesive luting procedures. According to Fahl,[5] this type of materials when subjected to heat and in combination with increased exposure to visible spectrum light, pressure or vacuum, and present greater conversion of the resin through increased polymerization. As a result, this conversion results in altered physical properties of the material, such as hardness, mechanical resistance, color stability, and biocompatibility.[6] The aim of this *in vitro* study was to examine the strength of composite veneers (taking fracture load as a guide) using three different preparation designs.

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MATERIALS AND METHODS

Thirty extracted, intact, human maxillary central incisors with similar dimensions were selected for this study. After inspecting them for defects or cracks, calculus and debris were removed by ultrasonic scaling. Selected teeth were stored in normal saline solution at room temperature throughout the study. Teeth were randomly divided into three groups (n = 10) with different preparation designs: Group 1 – feather preparation, Group 2 – bevel preparation, and Group 3 – incisal overlap-palatal chamfer. Impressions of the prepared cavities were taken with identical heavy body and light body impression material and working models were fabricated. Restorations of the cavities were performed with an identical composite material according to the manufacturer's instructions. After polymerization in a curing unit, the veneers were bonded to the teeth using resin cement. After loading the specimens to the failure (cyclic/stress path triaxial system) in a testing machine (TRITECH WF 10056, Wykeham Farrance, Milan, Italy), the fracture strength test was performed at a constant speed of 0.5 mm/min by applying force at a 45° angle to the long axis of the tooth. Data were analyzed by recording failure fatigue of every specimen. The mode of failure was determined as debonding or fracture at the incisal, gingival, or combined level on microscopic visualization (Olympus microscope SZ2-ILST model, Figure 1). The data were statistically analyzed using statistic package–SPSS version 23.

RESULTS

Composite veneers with incisal overlap-palatal chamfer (Group 3) showed highest fracture resistance (123.0 N) and bevel preparation (Group 1) showed minimum fracture resistance (100.4 N). The fracture resistance for feather preparation (Group 2) was 105.3 N. T-test for means shows a statistically significant difference in the fracture resistance of the designs ($P < 0.05$). Most commonly, debonding occurred in samples with feather preparation (80%) while fracture occurred in the other two groups (80%) [Table 1].

DISCUSSION

Clinical studies[7] have confirmed that veneers bonded to mandibular incisors are less susceptible to fractures and most fractures occur on veneers cemented to maxillary incisors.[8] This is due to less destructive nature of the forces of pressure that occur on the incisal edges.[9] This formed the basis for selecting the maxillary incisors as the teeth of choice in our study.

To achieve optimum results with veneers, it is necessary to identify the best design of preparation to achieve the best esthetic and mechanical outcome. Our *in vitro* study eliminated subjective factors such as strength of chewing pressure on mastication and the type of food. However, it is quite difficult to reproduce conditions analogue to those in the mouth. At present, literature assumes complex geometric shape of the veneers to be the cause of failure of composite veneers. Human teeth have strength and elasticity along with bonding characteristics that influence the results of *in vitro* examination.[10,11] In our study, we chose teeth with identical sizes and shape to avoid any bias. Mechanical characteristics are of great importance for successful restoration with veneers. There are many ambiguities and controversies regarding the veneers preparation designs in the literature. Most of the studies in literature have analyzed porcelain veneers as the veneer material and not the effect of the preparation design on the veneer failure.[12] In our study, we have used laboratory processed composite (has high proportion of inorganic fillers in the nanoscale range) resin that offers better handling and superior mechanical resistance and finish than hybrid composite materials. The matrix, based on a urethane dimethacrylate, is recognized for its toughness which is higher than that the frequently used BisGMA.[13,14] As per different studies conducted by Meijering *et al*.[15] and Alghazzavi[12] *et al*., reduction of incisal edge has no role in the survival rates and mechanical resistance of veneers and there was no statistical difference in fracture strength of the veneer depending of preparation design. However, Mirra and El-Mahalawy[16] had opposite results in an *in vitro* study. Most recommended preparation design for veneer is where the incisal edge is reduced.[17,18] On the other hand, some authors suggest that veneers made with incisal overlap (palatal chamfer) preparation type have the best tolerance of stress distribution.[8,19] The results of our study

Table 1: Relation between force applied and failure of veneers

n	1	2	3	4	5	6	7	8	9	10	Mean
Group 1											
Fracture line (N)	101	112	99	92	103	98	102	107	94	96	100.4 N
Mode of failure	D	D	D	D	F	D	D	D	D	F	
Localization	-	-	-	-	G	-	-	-	-	G	
Group 2											
Fracture line	97	114	110	101	105	104	115	101	102	104	105.3 N
Mode of failure	F	F	F	F	D	F	F	F	F	D	
Localization	I	I	I	I		I	I	I	I		
Group 3											
Fracture line	129	134	117	121	113	128	136	119	118	115	123 N
Mode of failure	F	F	D	F	F	F	F	D	F	F	
Localization	I	I		C	C	I	I		C	C	

C: Combination, D: Debonding, F: Fracture, I: Incisal, G: Gingival correspond to those of Schmidt *et al.*[20] and Akoglu and Gemalmaz.[21] In the present study, we found a statistically significant difference in the fracture resistance among the three preparation designs. The highest fracture resistance was found in veneers with incisal overlap-palatal chamfer. This was attributed to increased tooth surface available for bonding and enough space and minimum thickness of the composite cement available so that the stress applied to the facets is reduced.[22] The bevel preparation and feather preparation groups do not provide a definite path of placement while cementation of the veneer because of thin incisal edges of the prepared teeth which explains the lower fracture resistance. Our study corroborates previous findings the incisal edge of restoration being the location of the fracture due to the presence of larger stress.[23]

CONCLUSION

This study, though with limitations, concludes that the type of preparation has a significant effect on fracture load for composite veneers. The incisal overlap-palatal chamfer preparation design has the best fracture resistance compared to other designs. The study suggests that for results to be more significant, another *in vitro* study with a much larger sample and/or an *in vivo* study should be carried out.

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