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Fracture Resistance of Composite Veneers with Different Preparation Designs

SUMMARY

Background: *The aim of this in vitro study was to examine the fracture load of composite veneers using three different preparation designs.* ***Material and methods***: *Fifteen extracted, intact, human maxillary central incisors were selected. Teeth were divided into three groups with different preparation design: 1) feather preparation, 2) bevel preparation, and 3) incisal overlap- palatal chamfer. Teeth were restored with composite veneers, and the specimens were loaded to failure. The localization of the fracture was recorded as incisal, gingival or combined.* ***Results***: *Composite veneers with incisal overlap – palatal chamfer showed higher fracture resistance compared to feather preparation and bevel preparation. The mean (SD) fracture loads were: Group 1: 100.6±8.0 N, Group 2: 107.4±6.8 N, and Group 3: 122.0±8.8 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, preparation design, fracture resistance

Katerina Zlatanovska[1], Ljuben Guguvcevski[2], Risto Popovski[3], Cena Dimova[1], Ana Minovska[1], Aneta Mijoska[2]

[1]Faculty of Medical Sciences–Dental medicine
University "GoceDelcev" Stip, FYROM
[2]Department for Prosthodontic
Faculty of Stomatology
University "Ss. Cyril and Methodius"
Skopje, FYROM
[3]Faculty of Natural and Technical Sciences
University "GoceDelcev" Stip, FYROM

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Introduction

Patients' desire for aesthetic correction of the front teeth is constantly growing. There is increased number of patients with aesthetic demands. Advances in technology and dental materials provide us many alternatives and options in order to improve their smile and eliminate aesthetic disadvantages, such as: discolored teeth or crooked, chipped, broken teeth or median diastema[1,2]. There are many ways to re-establish bio-aesthetic relation and composite veneers are one of them. Simple technology, high aesthetics, mechanical resistance, low allergy-causing potential, effective cost, opportunity for clinical repairs, increase the use of composite veneers in clinical practice as a contemporary aesthetic solution[3].

Therefore, it is necessary to clarify and define the type of preparation which will give better performance of fixed-prosthetic works. The ideal scenario is to keep the bond completely in enamel. Labial and proximal surfaces should be uniform prepared, if possible, and no less than 0.3 mm to 0.5 mm[4]. The preparation's margins must be chamfered and in enamel[5]. Regarding the reduction of the incisal edge, preparation design can be classified as: *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 bucco-palatal tilt preparation over the entire tooth width); *incisal overlap or palatal chamfer* (the reduction of incisal edge with palatal extension preparation). An important decision that should be made before starting the preparation is whether the incisal edge will be reduced or not.

Indirect technique is used to fabricate a restoration in a dental laboratory. The composite veneers are bonded to the teeth by adhesive luting techniques and restore mechanical and biological function with minimally invasive procedures. According to Fahl[6] this type of materials when subjected to heat and in combination with increased exposure to visible-spectrum light, pressure or vacuum, present greater conversion of the resin through increased polymerization. Thereby, this conversion results in altered physical properties of the material, like hardness, mechanical resistance, color stability and biocompatibility[7].

The aim of this *in vitro* study was to examine the fracture load of composite veneers using three different preparation designs.

Methods and materials

Fifteen extracted, intact, human maxillary central incisors with similar dimensions were selected for this study. Teeth were inspected for defects or cracks, and external debris or calculus was removed by ultrasonic scaling. Selected teeth were stored in Normal saline solution (Nirma Ltd, Gujarat, India) at room temperature throughout the study.

Teeth were randomly divided into three groups (n=5) with different preparation design: 1) feather preparation, 2) bevel preparation, and 3) incisal overlap-palatal chamfer.

Impressions of the prepared cavities were taken with heavy body and light body impression material Express XT Regular Body and Express XT Putty Soft (3M ESPE Dental Products, Seefeld, Germany) and working models were fabricated. Restorations of the cavities were performed with a composite material (SR Adoro, IvoclarVivadent, Schaan, Liechtenstein) according to the manufacturer's instructions. The material was polymerized in a curing unit (Lumamat 100, IvoclarVivadent) and veneers were bonded to the teeth using a resin cement (Variolink Esthetic, IvoclarVivadent).

Subsequently, specimens were loaded 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. The force was applied at a 45˚ angle to the long axis of the tooth. Fatigue failure for each specimen was recorded and the data were statistically analyzed. The mode of failure was determined as debonding or fracture and subjected to microscopy visualization (Olympus microscope SZ2-ILST model, Figure 1). The localization of the fracture was classified as incisal, gingival or combined. The data were statistically analyzed using statistic package – SPSS version 23.

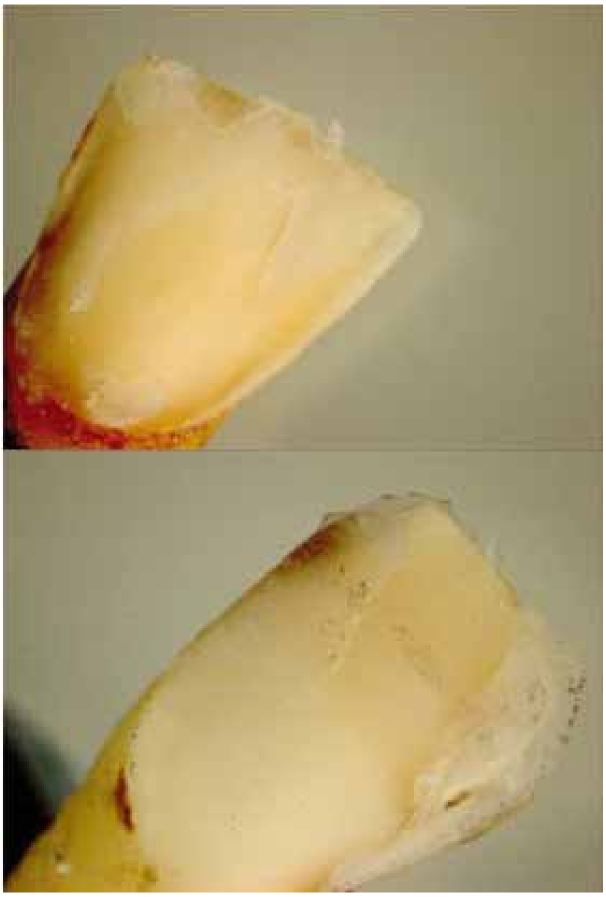

Figure 1.The visualization of the fracture.

Results

Regarding the maximum load, composite veneers with incisal overlap-palatal chamfer showed higher fracture resistance (122.0±8.8 N) compared to feather preparation (107.4±6.8 N) and bevel preparation (100.6±8.0 N). T-test for means showed a statistically significant difference in the fracture resistance was found among the three preparation designs ($p<0.05$). Regarding the type of failure, debonding of composite veneers was characteristic for feather preparation (80%), while fracture predominately occurred in the bevel preparation (80%) and incisal overlap (80%) groups. The most common localization of fractures was incisal (Table 1).

Discussion

Due to the actuality and more frequent use of veneers in everyday clinical practice, it is necessary to clearly define the type of preparation that will achieve better aesthetic and mechanical properties of fixed-prosthetic restorations.

Table 1. Fracture load, mode of failure and localization of fracture of composite veneers fabricated with different preparation design

	Feather preparation			Bevel preparation			Incisal overlap		
n	Fracture Load (N):	Mode of failure	Localization of fracture	Fracture Load (N):	Mode of failure:	Localization of fracture	Fracture Load (N):	Mode of failure:	Localization of fracture
1	99	Debonding	/	99	Fracture	incisal	129	Fracture	incisal
2	112	Debonding	/	116	Fracture	incisal	133	Fracture	incisal
3	99	Debonding	/	112	Fracture	incisal	116	Debonding	/
4	90	Debonding	/	103	Fracture	gingival	120	Fracture	combination
5	103	Fracture	gingival	107	Debonding	/	112	Fracture	combination
Mean	100.6			107.4			122		
Std.dev	7.956			6.804			8.803		
Std.error	3.567			3.051			3.947		

In the present study we employed *in vitro* testing which enables fast and effective analysis. In addition, experimental studies eliminate subjective factors such as: strength of chewing pressure, mastication and the food type. However, it is quite difficult to reproduce conditions analogue to those in the mouth. At the same time, in the literature there is not enough data for the examination standards and methodology of the fracture resistance of porcelain veneers. It is assumed that this is because of the complex geometric shape of the veneers.

Human teeth were used in this study because they have unique properties, such as strength, elasticity, bonding characteristics and enamel thickness that influence the results of *in vitro* examination[8,9]. On the other side, using human teeth has the limitations, because these are difficult to standardize based on size and age. Therefore, the teeth which had major differences in size were excluded from our sample. 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 which analyzed porcelain veneers presented that the material used in fabrication of veneers had an influence only on the fracture load value and not on the preparation design[10].

In our study we have used laboratory processed composite resin which is a micro-filled, light/heat cure composite. It is suitable for fabrication of both metal supported and metal free restorations such as inlays, onlays and veneers. This system offers few advantages over hybrid composite materials, like handling, plaque and mechanical resistance and surface finish. This is because of high proportion of inorganic fillers in the nanoscale range. Moreover, the matrix is based on a urethane dimethacrylate (UDMA) that is recognized for its toughness, which is higher than that of its predecessors or the frequently used BisGMA[11,12].

It is critical for the dentist to understand that the preparation design has big influence on the survival rate and therapy success[13]. Meijering[14] described that there were no differences in the survival rates and mechanical resistance of veneers whether the incisal edge was reduced or not. Similar results were obtained in *in vitro* study conducted by Alghazzavi[10] et al. The values they received show that there was no statistical difference in fracture strength of the veneer depending of preparation design.

Opposite results, with statistically significant differences in values between different types of preparation were achieved in *in vitro* study by Mirra[15]. The highest value for fracture resistance was described in veneers with bevel preparation, while veneers with incisal overlap-palatal chamfer preparation design showed lowest fracture strength.

Most of the authors recommend preparation design where incisal edge is reduced[16,17,18]. Considering the delicate and fragile nature of the restorations, some of the authors describe that veneers made with incisal overlap (palatal chamfer) preparation type have the best tolerance of stress distribution[13,19,20,21,22]. The results we gain in this study correspond also to the findings made by Schmidt et al.[23], Chaiyabutret al.[24] and Akogluand Gemalmaz[25]. They separately examined fracture resistance of ceramic veneers with different preparation designs and the higher value for fracture strength was confirmed for veneers with incisal overlap – palatal chamfer design.

In the present study, a statistically significant difference in the fracture resistance among the three preparation designs was found, with incisal overlap–palatal chamfer showing the highest fracture resistance this can be explained by an increased tooth surface available for bonding. It is very important to provide enough space and minimum thickness of the composite cement in order to reduce the stress applied to the facets[26], and the incisal overlap– palatal chamfer design provides a definite seat for cementation.

Lower fracture resistance in the bevel preparation and feather preparation groups can be explained by thin incisal edges of the prepared teeth which do not provide a definite path of placement while cementation of the veneer. Our study also confirms previous findings that fracture of the veneers usually appears on the incisal edge of restoration due to the presence of larger stress[27].

Fracture resistance also depends a lot from the direction of the applied force. Maxillary veneers during mastication and protrusion have interincisal angle of 135 degrees and it is not parallel to the longitudinal axis of the tooth[28]. Both, the functional and parafunctional forces applied to the palatal surface move the veneer facial. Clinical studies[29] have confirmed that veneers bonded to mandibular incisors are less susceptible to fractures, due to less destructive nature of the forces of pressure that occurs on the incisal edges[30]. Most of clinical fractures occur to veneers cemented to maxillary incisors[22].

Conclusion

Within the limitations of the present study, it can be concluded that the type of preparation has a significant effect on fracture load for composite veneers. Incisal overlap– palatal chamfer preparation design significantly increases the fracture resistance compared to feather and bevel preparation designs.

References

1. Magne P, Perroud R, Hodges JS, Belser UC. Clinical performance of novel-design porcelain veneers for the rec Gemalmazovery of coronal volume and length. *Int J Periodontics Restorative Dent*, 2000; 20:440-457.
2. Fradeani M, Redemagni M, Corrado M. Porcelain laminate veneers: 6- to 12-year clinical evaluation-a retrospective study. *Int J Periodontics Restorative Dent*, 2005; 25:9-17.
3. Dikova T, Abadjiev M, Balcheva M. Clinical application of the contemporary nano-materials (part 1 – laboratory composites). *J of IMAB*, 2009; 2:67-70.
4. Magne P, Douglas WH. Additive contour of porcelain veneers: a key element in enamel preservation, adhesion, and esthetics for aging dentition. *J Adhes Dent*, 1999; 1:81-92.
5. Friedman MJ. Porcelain veneer restorations: a clinician's opinion about a disturbing trend. *J Esthet Restor Dent*, 2001;13:318-327.
6. Fahl N. The direct/indirect composite resin veneers: a case report. *Int Aesthet Chro*, 1996; 8:627-638.
7. Covey DA, Tahaney SR, Davenport JM. Mechanical properties of heat-treated composite resin restorative materials. *J Prosthet Dent*, 1992; 68:458-461.
8. Rueggeberg FA. Substrate for adhesion testing to tooth structure- review of the literature. *Dent Mater*, 1991; 7:2-10.
9. Sadighpour L, Geramipanah F, Allahyari S, Sichani BF, Fard MJK. In vitro evaluation of the fracture resistance and microleakage of porcelain laminate veneers bonded to teeth with composite fillings after cyclic loading. *J Adv Prosthodont*, 2014; 6:278-284.
10. Alghazzavi T, Lemons J, Liu P, Essig M, Janowski G. The failure load of CAD/CAM generated zirconia and glass-ceramic laminate veneers with different preparation designs. *J Prosthet Dent*, 2012; 108:386-393.
11. D'Souza, Kumar M. Esthetics and Biocompatibility of Composite Dental Laminates. *MJAFI* 2010; 66:239-243.
12. Ramandeep, Dhillon JS, Passi S, Raghav, Chhabra A. Effect of reinforcement on the fracture resistance of endodontically treated molars by various bonded restorations -an in vitro study. *DJAS*, 2015; 3:103-111.
13. Li Z, Yang Z, Zuo L, Meng Y. A three-dimensional finite element study on anterior laminate veneers with different incisal preparations. *J Prosthet Dent*, 2014; 112:325-333.
14. Meijering AC, Creugers NH, Roeters FJ, Mulder J. Survival of three types of veneer restorations in a clinical trial: A 2.5 year interim evaluation. *J Dent*, 1998; 26:563-568.
15. Mirra G, El-Mahalawy S. Fracture Strength and Microleakage of Laminate Veneers. *Cairo Dent J*, 2009; 25:245-254.
16. Christensen GJ, Christensen RP. Clinical observations of porcelain veneers: A three-year report. *J Esthet Dent*, 1991; 3:174-179.
17. Shetty A, Kaiwar A, Shubhashini N, Ashwini P, Naveen DN, Adarsha MS et al. Survival rates of porcelain laminate restoration based on different incisal preparation designs: An analysis. *J Conserv Dent*, 2011; 14:10-15.
18. Smales RJ, Etemadi S. Long term survival of porcelain laminate veneers using two preparation designs: A retrospective study. *Int J Prosthodont*, 2004; 17:323-326.
19. Highton R, Caputo AA, Mátyás J. A photo-elastic study of stresses on porcelain laminate preparations. *J Prosthet Dent*, 1987; 58:157-161.
20. Magne P, Douglas WH. Design optimization and evolution of bonded ceramics for anterior dentition: Finite Element Analysis. *Quintessence Int*, 1999; 30:661-672.
21. Zarone F, Apicella D, Sorrentino R, Ferro V, Aversa R, Apicella A. Influence of tooth preparation design on the stress distribution in maxillary central incisors restored by means of alumina porcelain veneers: A 3d-finite element analysis. *Dent Mater*, 2005; 21:1178–1188.
22. Jankar AS, Kale Y, Kangane S, Ambekar A, Sinha M, Chaware S. Comparative evaluation of fracture resistance of Ceramic Veneer with three different incisal design preparations - An In-vitro Study. *J Int Oral Health* 2014; 6:48-54.
23. Chaiyabutr Y, Phillips K.M, Polly S Ma. Comparison of load-fatigue testing of ceramic veneers with two different preparation designs. *Int J Prosthodont*, 2009; 22:573-575.
24. Schmidt KK, Chiayabutr Y, Phillips KM, Kois JC. Influence of preparation design and existing condition of tooth structure on load to failure of ceramic laminate veneers. *J Prosthet Dent*, 2011; 105:374-382.

25. Akoglu B, Gemalmaz D. Fracture resistance of ceramic veneers with different preparation designs. *J Prosthodont*, 2011; 20:380-384.
26. Magne P, Versluis A, Douglas WH. Effect of luting composite shrinkage & thermal stress distribution in porcelain laminates veneers. *J Prosthet Dent*, 1999; 81:335-344.
27. Hussain F, Al-Huwaizi B.D.S. A finite element analysis of the effect of different margin designs and loading positions on stress concentration in porcelain veneers. *J Coll Dentistry*, 2005; 17:8-12.
28. Castelnuovo J, Tjan AH, Phillips K, Nicholls JI, Kois JC. Fracture load and mode of failure of ceramic veneers with different preparations. *J Prosthet Dent*, 2000; 83:171-180.
29. Wall JG, Johnston WM. Incisal edge strength of porcelain laminate veneers restoring mandibular incisors. *Int J Prostohdont*, 1992; 5:441-446.
30. Faunce FR, Myers DR. Laminate veneer restorations of permanent incisors. *J Am Dent Assoc*, 1976; 93:790-792.

Corresponding author:

Katerina Zlatanovska
Faculty of Medical Science – Dental Medicine
University “GoceDelcev” Stip
KrsteMisirkov bb, 2000 Stip, FYROM
katerina.zlatanovska@ugd.edu.mk