The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 19(3): 64-68, 2024 www.thebioscan.com

COMPARATIVE EVALUATION OF EFFECT OF INCISAL PREPARATION DESIGN ON FRACTURE RESISTANCE OF TWO DIFFERENT COMPOSITE VENEERS: AN IN-VITRO STUDY

[1]Dr. Sai Krishna Manchala, [2]Dr. M. Pratap kumar, [3]Dr. P. Samba Shiva Rao,

[4]Dr. R. Janavathi, [5]Dr. J. Deepa, [6]Dr. K. Sowmya

[1] Postgraduate, [2] MDS, Professor, HOD, [3] MDS, Professor, [4] MDS, PHD, Professor, [5] MDS, Senior lecturer,

[6] MDS, Senior lecturer,

Emails: sai10manchala@gmail.com, pratapmukka@gmail.com, pssrao@gmail.com, jandr@rediffmail.com, dr.deepapawar@gmail.com, Soumya.kotta@gmail.com

Contact number: 8897258555

Orcid id: 0009-0003-5446-1152, 0009-0008-8284-6056, 0009-0008-5872-6089, 0000-0002-8847-7836, 0009-0000-6580-4518, 0009-0008-9745-9809

[1,2,3,4,5,6] Department of Conservative Dentistry and Endodontics, Meghna Institute of Dental Sciences, Nizamabad

Corresponding author: Dr. Sai Krishna Manchala

Email: **sai10manchala@gmail.com**

DOI: https://doi.oíg/10.63001/tbs.2024.v19.i03.pp64-68

KEYWORDS
Veneers, butt joint, incisal overlap-palatal chamfer, fracture resistance.

Received on:

25-07-2024

Accepted on:

15-11-2024

ABSTRACT

Background: To evaluate the fracture resistance of two different composite veneers with two different preparation designs.

Materials and Methods: A total of 60 extracted human maxillary central incisors were prepared and divided into two groups based on the type of composite veneer material: Group I: Filtek Z250 XT (n = 30), Group II: CHARISMA [R] Smart (n = 30). They were further divided into two subgroups based on the incisal preparation design: Subgroup A: Butt joint (n = 15), and Subgroup B: Incisal overlap-palatal chamfer (n = 15). Standard veneer preparations were done and composite veneers were fabricated with the respective composites. All the specimens were mounted on acrylic blocks and loaded to failure using a Universal testing machine (UTM).

Statistical analysis: The obtained data were statistically analysed using the Mann-Whitney U test.

Results: Filtek Z250 XT with incisal overlap (Group I subgroup B) showed higher fracture resistance followed by Filtek Z250 XT with butt joint.

Conclusion: It was concluded that Filtek Z250 XT has a higher fracture resistance than CHARISMA [R] Smart and incisal overlap preparation has a higher fracture resistance than butt joint preparation.

INTRODUCTION

The restorative treatment of discoloured, malpositioned, or fractured anterior teeth is still a problem for dental professionals. Although full crowns yield extremely good results, one major disadvantage is thought to be the loss of healthy tooth structure.[1] Minimally invasive esthetic treatments are advantageous over full crowns as they avoid tooth weakening caused by reductions of tooth preparations. For this reason, the use of composite veneers has increased nowadays due to their excellent esthetic properties and translucency.[2]

The long-term prognosis of these restorative materials is especially essential since they are subjected to persistent masticatory stresses inside the mouth, which might induce increased failure of these restorations. So, the type of composite material, preparation design and the adhesive system influence the prognosis of composite veneers.[3]

The composite veneers are bonded to the teeth by adhesive luting techniques and restore mechanical and biological function with minimally invasive procedures. To improve the performance of fixed prosthetics, it's important to establish the appropriate preparation. Ideally, the bond should remain entirely in the enamel. Labial preparation should have a thickness of at least 0.3 - 0.5 mm and proximal reduction is not recommended for better esthetics except in a few situations like malocclusion. Incisal edge reduction preparation is of four types: window (non-reduced), feather (non-reduced), bevel (reduced with bucco-

palatal tilt), and incisal overlap or palatal chamfer (reduced with palatal extension).[4]

Single Bond Universal Adhesive (3M) is a eighth generation dental adhesive. It is the single-bottle solution for all surfaces and can be used reliably in total-etch, self-etch or selective-etch mode for both direct and indirect restorations. It's composition includes MDP phosphate monomer, dimethacrylate resins, HEMA, vitrebond™ copolymer, filler, ethanol, water, initiators, silane.[5]

RelyX U200 (3M) is a self-adhesive resin cement. It is a dual cure resin cement with increased mechanical properties and excellent overall adhesion performance. It consists of base paste: methacrylate monomers containing phosphoric acid groups, methacrylate monomers, silanated fillers, initiator components, stabilizers, rheological additives; catalyst paste: methacrylate monomers, alkaline (basic) fillers, silanated fillers, initiator components, pigments, stabilizers.[6]

Filtek™ Z250 XT (3M) is visible light-activated nanohybrid universal composite designed for use in both anterior and posterior restorations. Its composition includes resin matrix: Bis-GMA, UDMA, Bis-EMA, PEGDMA and TEGDMA; filler: Surface-modified zirconia/silica with a median particle size of approximately 3 µm or less. Non-agglomerated/non-aggregated 20 nanometre surface-modified silica particles. The filler loading is 82% by weight (68% by volume).[7]

CHARISMA ® Smart (Kulzer) is a submicron-hybrid universal restorative material. Its composition includes matrix: Bis-EMA, HDMA, TEGDMA and filler: barium, aluminum fluoride glass filler of 0.02-2 µm, 5 vol% pyrogenic silicon dioxide filler of 0.02–0.07µm. The filler loading is 78% by weight (65% by volume).[8]

This in-vitro study examined the fracture resistance of two different composite veneers with two different preparation designs.

Materials and Methods:

Study Design: This study was reviewed and approved by the Institutional Ethical Committee (approval number: MIDS/MDS/CONS/010). Power analysis was performed using G*Power software [alpha (α) = 0.05; power (1-β) = 0.80]. It indicated a requirement of 60 samples.

Sample preparation: Sixty freshly extracted human maxillary central incisors of approximately same size were collected. All teeth were visually examined under blue light transillumination to determine that the enamel was free from cracks. Teeth with pre-existing restorations, cracks, wear, or root canal treated are excluded. The teeth were cleaned using an ultrasonic scaler to render them free from calculus, tissue tags and stored in distilled water at room temperature.

Tooth preparation: All the samples were mounted on modelling wax and putty impression was taken prior to veneer preparation. Teeth were then randomly divided into two groups based on the type of composite veneer material: Group I: Filtek Z250 XT (n=30), Group II: CHARISMA ® Smart (n=30). They were further divided into two subgroups based on the incisal preparation design: Subgroup A: Butt joint (n=15), Subgroup B: Incisal overlap-palatal chamfer (n=15). Depth indentation grooves of 0.3 mm were placed on the labial aspect of the samples using DM-303 bur (MANI Inc.) (Figure 1). The grooves were marked with indelible pencil. Biplanar tooth preparation (i.e., gingival 2/3rd and incisal 1/3rd) is done on the labial aspect of all the samples with TR 13F bur (MANI Inc.) (Figure 2). Then incisal preparation was done based on the groups divided using TR 13F bur.

Veneer Preparation: Veneers were fabricated using composites based on the groups divided (Group I: Filtek Z250 XT, Group II: CHARISMA ® Smart) using putty impression as index and light cured for few seconds. Later, the partially polymerized restoration is carefully removed from the non-bonded tooth surface.

Then all the samples were mounted on acrylic block of 2*2*2 cm. Single Bond Universal Adhesive was applied to the intaglio surface of the fabricated veneers and labial aspect of prepared tooth samples. The applied adhesive was gently air dried for approximately 5 seconds to evaporate the solvent and light cured for 10 seconds. The fabricated veneers were cemented to the prepared tooth surface with RelyX U200 and light cured for 20 seconds. Finally finishing and polishing is done.

A universal testing machine (FIE PVT. LTD Model: UTES HGFL 40) was used to conduct the fracture strength test. The load was applied at a crosshead speed of 0.5 mm/min using a modified plunger (steel rod of 3.6mm diameter) attached to the machine's upper movable compartment at the veneer's facial area. The load was applied at a 135° to the long axis of the tooth (Figure 3). The maximum fracture load for each sample is recorded in Newton (N).

Statistical Analysis:

The statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25.0. The resultant values for the fracture resistance were statistically analyzed using the Mann-Whitney U test. The level of significance was set at $p \leq 0.05$.

RESULTS:

The comparisons were made using the Mann-Whitney U test, a non-parametric test which indicates that there are significant differences in fracture resistance between the different subgroups in the study. The lowest fracture resistance is recorded in the IIA group (571.0000 N) followed by IIB group (659.0000 N). The highest fracture resistance is recorded in the IB group (1083.0000 N) followed by IA group (786.0000 N). The mean difference is highest between IB and IIB groups (424.00) and lowest between IA and IB groups (-297.00). All comparisons had p-values less than 0.05, suggesting statistically significant variations in mean fracture resistance among subgroups of the same group and between the same subgroups across groups. Mean values, standard deviation (Table 1), and mean comparison of fracture resistance between groups and subgroups (Table 2) are tabulated.

DISCUSSION

Veneers are one of several treatment options available to improve esthetics. They are the least intrusive and conservative. Veneers are preferable over crowns as they don't have the disadvantage of extensive tooth preparation and damage to the gingival tissues. (Aristides & Dimitra, 2002). So, veneer restorations have gained popularity in the field of dentistry in recent years.[9]

Recent developments in commercial composites have primarily involved filler system alterations. Increasing filler quantities and lowering particle size improves composite characteristics significantly.[10] So, this in vitro study compares the load-bearing capacity of central incisors restored with two different composite veneers, which have varying mechanical properties. Filtek Z250 XT (3M) is a nanohybrid universal composite and CHARISMA ® Smart (Kulzer) is a submicron-hybrid universal composite.

It is critical for the dentist to understand that the preparation design has a big influence on the survival rate and therapy success. Most of the authors recommend a preparation design where the incisal edge is reduced. So, in this study, butt joint and incisal overlap designs have been tested. 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 and longevity.[11] But, according to Castelnuovo et al.[12] having a chamfer finish line does not improve the restoration's lifespan.

Fabrication of veneers can be done by three methods: direct, indirect, and direct-indirect. In this study, the direct-indirect method was used. Advancements in composite materials, instrumentation, and chairside light-curing have led to renewed interest in the direct-indirect composite veneer method, which offers advantages over directly-placed veneers. The direct-indirect composite technique offers a unique approach to managing certain clinical conditions. However, it has certain limitations, such as that for teeth with undercuts, direct technique is preferred.[13]

Successful restorations require strong and long-lasting adhesion between enamel and dentine, as well as the use of appropriate restorative material. According to Hagberg C. (1987), physiologic biting forces in adults range from 108–230 N.[9] Both the materials used in this study are superior, showing values in the range of 570–1100 N, indicating that they can be used clinically.

In this study, Filtek Z250 XT (Group I) showed the highest fracture resistance. While the specimen restored with CHARISMA [R] Smart (Group II) showed least resistance to fracture. This can be attributed to the mechanical behaviour which depends on the concentration and particle size of the inorganic filler. Filtek Z250 XT being a nano composite, an increased filler load has been achieved without increasing their viscosity and thus increasing the mechanical properties such as tensile strength, compressive strength and other mechanical properties.[9]

Incisal overlap-palatal chamfer preparation has higher fracture resistance than butt joint preparation. This can be explained by an increased tooth surface available for bonding. Also, incisal overlap- palatal chamfer design provides a definite seat for cementation.[4] This can also be attributed to veneers with a butt-joint may have more than one path of insertion while veneers with incisal overlap-palatal chamfer has single path of insertion.[11] Veneers with single path of insertion are advantageous because it avoids displacement during cementation. The results of this study are in accordance with those of Schmidt et al.[14], Chaiyabutr et al.[15], Zarone et al.[16]

Limitations:

The sample size of this study is relatively small. Fracture resistance may also depend on the formation of a continuum between tooth surface, adhesive and restorative material. However, in oral environment the restored teeth are subjected to variety of challenges in addition to masticatory load, including prolonged exposure to moisture, temperature and pH fluctuation with intake of different foods along with exposure to variety of bacteria and enzymes. Further studies taking the above challenges into account are needed.

CONCLUSION

Within the limitations of the present study, it can be concluded that the type of composite material and veneer preparation design has a significant effect on fracture resistance. The results suggest that Filtek Z250 XT, a nanohybrid composite, demonstrated superior fracture resistance due to its higher filler content, making it a more durable choice for clinical use.

Moreover, the study examined the impact of preparation design on the success of veneer restorations, finding that incisal overlap-palatal chamfer preparation offers higher fracture resistance compared to butt joint preparation. This design allows for a stronger bond between the tooth surface and the veneer, providing better stability during cementation.

REFERENCES

- 1)Turkaslan S, Tezvergil-Mutluay A, Bagis B, Shinya A, Vallittu PK, Lassila LV. Effect of intermediate fiber layer on the fracture load and failure mode of maxillary incisors restored with laminate veneers. Dent Mater J. 2008;27(1):61–8
- 2)Linhares LA, Pottmaier LF, Lopes GC. Fracture resistance of veneers in premolars. Eur J Dent 2018;12:191-8.
- 3)Tomer AK, Raina AA, Ayub FB, Behera A, Mittal N, Vaidya S, et al. Fracture strength of composite veneers using different restorative materials: A comparative in vitro study. International Journal of Applied Dental Sciences. 2017;3:465-8.
- 4)Zlatanovska K, Guguvcevski L, Popovski R, Dimova C, Minovska A, Mijoska A. Fracture resistance of composite veneers with different preparation designs. Balkan J Dent Med. 2016;20(3):99–103.
- 5)3m Single bond universal adhesive technical product profile. Available at https://multimedia.3m.com/mws/media/1279637O/3m-single-bond-universal-adhesive-technical-product-profile.pdf. Accessed February 07, 2023.
- 6)Pedreira APR do V, D'Alpino PHP, Pereira PNR, Chaves SB, Wang L, Hilgert L, et al. Effects of the application techniques of self-adhesive resin cements on the interfacial integrity and bond strength of fiber posts todentin. J Appl Oral Sci. 2016;24(5):437–46.
- 7)Filtek Z250 XT technical data sheet. Available at https://multimedia.3m.com/mws/media/734318O/filtek-z250-xt-technical-data-sheet.pdf. Accessed February 07, 2023.
- 8)Colak G, Katirci G. In Vitro evaluation of the effects of whitening toothpastes on the color and surface roughness of different composite resin materials. BMC Oral Health. 2023;23(1).
- 9)Balpreet Kaur, Renu Bala Sroa, Jagvinder Singhmann, Navjotsingh Khurana, Summeta Sandhu, Sunakashi Sharma, et al. A comparative evaluation of the fracture resistance of direct composite Veneers using different restorative materials – an in vitro study. International Journal of Current Research, 13, (02), 16207-16211.
- 10)Bayraktar ET, Atali PY, Korkut B, Kesimli EG, Tarcin B, Turkmen C. Effect of modeling resins on microhardness of resin composites. Eur J Dent. 2021;15(03):481–7.
- 11)Alothman Y, Bamasoud MS. The success of dental veneers according to preparation design and material type. Open Access Maced J Med Sci. 2018;6(12):2402–8.
- 12)Castelnuovo J, Tjan AHL, Phillips K, Nicholls JI, Kois JC. Fracture load and mode of failure of ceramic veneers with different preparations. J Prosthet Dent. 2000;83(2):171–80.
- 13)Fahl N Jr, Ritter AV. Composite veneers: The direct–indirect technique revisited. J Esthet Restor Dent. 2021;33(1):7–19.
- 14)Shmidt 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.
- 15)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.
- 16)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(12):1178–88.

Table 1: Mean fracture resistance and standard deviation of groups and subgroups

Group	Subgroup	n	Mean (N)	Standard Deviation
I	A	15	786.0000 N	29.95234
	B	15	1083.0000 N	19.51800
II	A	15	571.0000 N	31.71180
	B	15	659.0000 N	28.40188

Table 2: Mean comparison of fracture resistance among groups and subgroups

Comparison	Mean Difference	Test statistic	p-value
IA vs IB	-297.00	-2.741	**0.006***
IIA vs IIB	-88.00	-2.214	**0.023***
IA vs IIA	215.00	-2.741	**0.009***
IB vs IIB	424.00	-2.741	**0.004***

The Mann-Whitney U test was employed; $p \leq 0.05$ considered statistically significant
The asterisk (*) indicates statistically significant findings

Figure 1. Tooth preparation with DM-303 bur.

Figure 2. Tooth preparation with TR 13F bur.

Figure 3. Sample under Universal Testing Machine.

Conflict of Interest:
All authors declare that they have no conflicts of interest.
Funding Source:
All authors declare that they did not receive any funding for this study.
Statement of Informed Consent:
As this is an in-vitro study there is no informed consent.
Ethics:
This study was reviewed and approved by the Institutional Ethical Committee of Meghna Institute of Dental Sciences with approval number: MIDS/MDS/CONS/010.