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FRACTURE RESISTANCE OF CAD/CAM LITHIUM DISILICATE VERSUS REINFORCED COMPOSITE OCCLUSAL VENEERS WITH TWO PREPARATION DESIGNS (AN IN VITRO STUDY)

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ABSTRACT

Aim. This study was performed to assess the impact of preparation design and material type on the fracture resistance and mode of failure of occlusal veneers after thermocycling.

Material and methods. A total number of twenty extracted lower premolars were divided randomly into two main groups according to occlusal veneer preparation design; Group 1 (n=10): Planar occlusal preparation with circumferential chamfer finish line and Group 2 (n=10): Planar occlusal preparation without circumferential chamfer finish line. Each group was subsequently divided into two subgroups according to the materials used; Group (R): Rosetta SM Lithium disilicate ceramics blocks and Group (B): Brilliant Crios reinforced composite blocks. All the teeth were prepared to receive occlusal veneers according to specific guidelines to ensure standardized preparation then scanned using a digital scanner. Brilliant Crios and Rosetta SM occlusal veneers were fabricated using CAD/CAM milling of blocks following the manufacturer instructions. After surface treatment of both occlusal veneers and natural teeth, cementation using an adhesive resin cement was done. All the samples were thermally aged for 3000 cycles then a compressive load was applied till fracture. Each sample was examined to identify the failure mode. Data were statistically analysed via two-way ANOVA test ($p<0.05$).

Results. B1 recorded the highest statistically significant fracture resistance and the lowest group was R2. While there is no statistically significant difference between B2, R1 and R2. Regarding the failure mode, all reinforced composite occlusal veneers showed favorable failure mode in both preparation designs. While only 50% of lithium disilicate occlusal veneers showed favorable failure mode.

Conclusions. Reinforced composite block exhibited superior fracture resistance and advantageous failure characteristics compared to lithium disilicate ceramic. The planar preparation with a circumferential chamfer finish line yields superior outcomes compared to the group without a chamfer finish line.

KEYWORDS: Occlusal veneers, Table tops, Composite blocks, Lithium disilicate

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INTRODUCTION

Conservatism is one of the main concerns of contemporary dentistry as it affects the survival rate of teeth and restorations. The continuous awareness of conservatism in addition to the advancement of dental materials have facilitated the emergence of treatment options that successfully fulfill the biological, mechanical and esthetic objectives of minimally invasive dentistry.[1]

Our current knowledge allows us to introduce minimally invasive bonded partial coverage restorations that fulfill the primary criteria of contemporary dentistry as they provide a conservative modality compared to full coverage restorations facilitated by advancements in techniques and materials.[2] Partial coverage all ceramic restorations were introduced to achieve this goal as they preserve tooth structure more than other full coverage involving treatment options. One of these conservative treatment options is occlusal veneer. It is indicated when occlusal enamel is reduced in thickness, exposing the underlying dentin as it is worn down or severely eroded due to multi-factorial etiology including dietary habits, systemic diseases or oral habits that lead to wearing of tooth structure.[3]

Occlusal veneers have to be with proper mechanical properties to withstand the occlusal load without being fractured. Various factors may have an influence on occlusal veneers' fracture resistance such as the preparation design in addition to the type and the thickness of the material.[4] They may be constructed from variety of bondable ceramics as lithium disilicate ceramic that demonstrates excellent mechanical features due to their interconnecting needle-like crystals presented in a glassy matrix.[5]

CAD/CAM reinforced composites exhibit enhanced mechanical capabilities compared to direct resin composites due to their advanced formulation and polymerization techniques under elevated temperature and pressure. They combine the advantageous characteristics of ceramics, including longevity, an enamel-like surface quality, esthetic appeal, and stain resistance with the beneficial properties of resin composite including superior resiliency, ease of milling, repair and polishing.[6] Moreover, they have a similar modulus of elasticity to dentin and stress absorbing properties. So they can be considered as a suitable choice of occlusal veneers.[7,8]

The fracture pattern of the restorative system is a critical criterion that influences tooth durability. It is significantly affected by the preparation design and qualities of the materials.[9] Repairable fractures are preferred to irrepairable or catastrophic ones which involve both the restoration and tooth as they may result in either tooth extraction or necessitate extensive surgical procedures for optimal restoration, which are typically difficult, time-consuming, and costly.[10]

Based on the aforementioned, our study was performed to evaluate the impact of preparation design and material selection on the fracture resistance of occlusal veneers. The hypothesis stated that there would be no difference in fracture resistance between occlusal veneers fabricated from two different materials, regardless whether a circumferential chamfer finish line is prepared on not.

METHODOLOGY

Teeth Allocation

The suggested sample size was twenty samples divided into two main groups (n=10). A total number of twenty extracted lower premolar teeth for periodontal and orthodontic purposes were collected. They should be free of caries, cracks or fracture with similar dimension as possible measured using a digital caliper (digital vernier caliper, Hogetex) at the level of cemento-enamel junction. They were disinfected by 5% sodium hypochlorite for 15 minutes then cleaned with ultrasonic cleaner and stored in distilled water at room temperature to avoid dryness.[2]

All teeth were mounted in epoxy resin up to 2mm beneath cemento-enamel junction for easier handling during preparation, cementation and testing procedures.[11] The teeth were divided randomly into four groups according to occlusal veneer preparation and the selected material as shown in Tables 1 and 2.

Teeth Preparation

All the preparations were conducted consistently by the same operator as shown in the Fig. 1. To standardize the preparation, an addition silicone putty indices (Elite HD, Zhermack, Italy) were taken for each tooth before preparation and cut in bucco-lingual dimension. A calipered periodontal probe was used after preparation to check the amount of reduction accurately.

A four-wheels stone depth cutter (FG S12 Diamond Intensive, Switzerland) was used to create depth cuts with 1.2mm depth in oblique position parallel to cusp slopes while the tip in the central fossa and shank at the cusp tip in (Fig. 2). The tooth structure between these grooves was reduced at high speed and under coolant using a rounded end tapered stone (Mani, Jaban).[12]

The group 1 was prepared with a circumferential 0.7 mm chamfer finish line positioned on healthy tooth structure above the height of contour using a rounded end tapered stone with 8 degrees coronal convergence.[13] Finishing and rounding of sharp edges of all preparations were done using fine-grit finishing abrasives burs.

Occlusal Veneers Fabrication

Each preparation was scanned using desktop extraoral scanner (SHINING D200+) and transformed into STL format. Subsequently, the DentalCAD 3.1 Rijeka; exocad; GmbH was used for restoration designing using the individual biogeneric mode for all samples. The thickness of the restorations was standardized to 1.2mm. Die spacer was set to 50 µm to provide a space for the luting cement. The STL files were imported to Coritec 250i (imes-icore, Eiterfeld) to mill all the 20

Table (1). Samples allocation

Material \ Preparation design	Planar reduction with circumferential chamfer finish line (1)	Planar reduction without circumferential chamfer finish line (2)	Total
Brilliant Crios **(B)**	**B1** n=5	**B2** n=5	10
Rosetta SM **(R)**	**R1** n=5	**R2** n=5	10
Total	10	10	20

Table (2). Name and product details of the materials used

Material	Description	Composition	Lot number	Manufacturer
BRILLIANT Crios	Nano-hybrid composite blocks Shade A2 LT 14	70 wt% Barium glass (size < 1.0 µm), amorphous silica (size < 20 nm), resin matrix (cross-linked methacrylates) and inorganic pigments	M74908	Coltène Whale dent, Switzerland
Rosetta SM	Lithium disilicate blocks Shade A1 LT C14	SiO2 (57–80%), Li2O (11–19%), K2O (0–13%), P2O5 (0–11%), ZrO2 (0–8%), Al2O3 (0–5%), MgO (90–5%) and coloring oxides (0–8%)	W82636	Hass, Gangneung, Korea

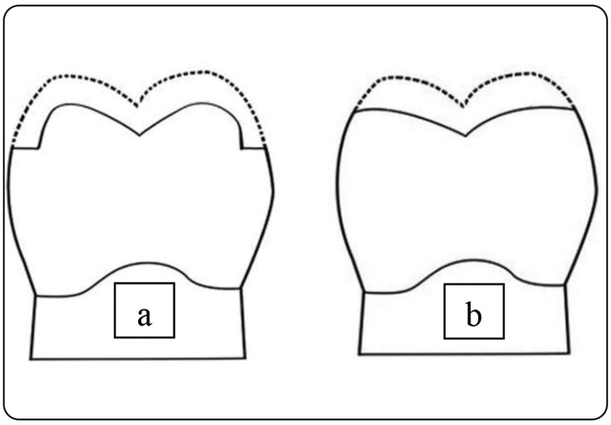

Fig. (1) A diagram showing two different occlusal veneers preparation designs a) Planer reduction with a circumferential chamfer finish line b) Planer reduction without a circumferential chamfer finish line.

Fig (2). Four-wheels stone depth cutter used to create depth cuts with 1.2mm depth in oblique position parallel to cusp slopes

blocks; 10 blocks for Brilliant Crios and 10 blocks for Rosetta SM.

After milling Rosetta occlusal veneers, they received crystallization cycle using Programat P510 ceramic furnace (Ivoclar Vivadent AG., Liechtenstein). Then they were over-glazed using IPS e.max CAD Crystall/Glaze Paste thinned with IPS e.max CAD Crystall/Glaze Liquid (Ivoclar Vivadent AG. Schaan, Liechtenstein).[14] While Brilliant Crios veneers were finished and polished using DIATECH finishing and polishing kit (Coltène, Switzerland) following the manufacturer instructions.[15] All occlusal veneers were carefully checked for any defects and verified for accurate seating and marginal integrity. Then a proper surface treatment was done for both prepared teeth and occlusal veneers before cementation.

Cementation Procedures

After teeth cleaning and drying, a phosphoric acid of 37.5% (B&E Co.ltd, Korea) was applied selectively to the enamel for 15s followed by 15 seconds rinsing and blot drying to avoid desiccation of denting. Then a coat of bonding agent (Bisco. inc. schumburg. U.S.A) was applied, agitated for 5 seconds then left for 10 seconds and gently air thinned before curing using a high intensity LED device for 40 seconds.

For group (B), air abrasion of the fitting surface was performed using 50 μm Al_2O_3 at 1.5 bar pressure then cleaned and air dried. A coat of bonding agent was applied to the sandblasted bonding surface of the cleaned restoration and rubbed in for 20 seconds.[2] Excess adhesive was removed with compressed air for 5 seconds. Meanwhile in group (R), 9.5% hydrofluoric acid etch (Bisco. inc. schumburg. U.S.A) was used for acid etching of the fitting surfaces for 20 seconds then washed using air-water spray for 30 seconds then air dried. Silane coupling agent (Bisco. inc. schumburg. U.S.A) was applied and rubbed on the fitting surface then left to dry for 1 minute.[16]

A dual cure self-adhesive resin cement (Duo-Link Universal, Bisco) was injected through an auto-mix tip on the occlusal surface of the teeth. The restorations were subsequently positioned on the teeth and verified for proper seating using an ultrasonic seating tip (G22, NSK, Japan).[2] To standardize the static load applied during cementation, a cement device with static load of 3 kg was used. Initial light curing was applied for each surface for 2 seconds to allow easier removal of excess cement using a sharp explorer followed by 40 seconds light curing for each surface to ensure complete curing. The samples were kept in distilled water for 24 hours before testing at room temperature.

Thermocycling Procedures

Thermocycling (Thermocycler, SD Mechatronik, Feldkirchen-Westerham, Germany) was done for all samples for 3000 cycles between temperature 5^{o}c and 55^{o}c to simulate the oral environment. Dwell times were 30 seconds in each water bath with a lag time 5 seconds.[17] After thermocycling, the samples were inspected for further cracks or fractures before undergoing the final fracture resistance test.[18]

Fracture Resistance Test

Each sample was mounted on an universal testing machine (3345; Instron, Norwood, MA, USA) which is computer controlled with 5 kN load cell and data were recorded using computer software (BlueHill universal Instron England). The sample was fixed to the lowest immobile compartment of the testing machine by tightening screws. The fracture test was done using a metallic rod with a 3.6 mm diameter spherical tip attached to the top moveable compartment of the testing machine. Compressive load was applied at 1 mm/min cross-head speed, with a tin foil sheet interposed (Fig. 3).[19] The failure load was recorded via the same software after an audible crack then confirmed by a sudden drop in the load-deflection curve.

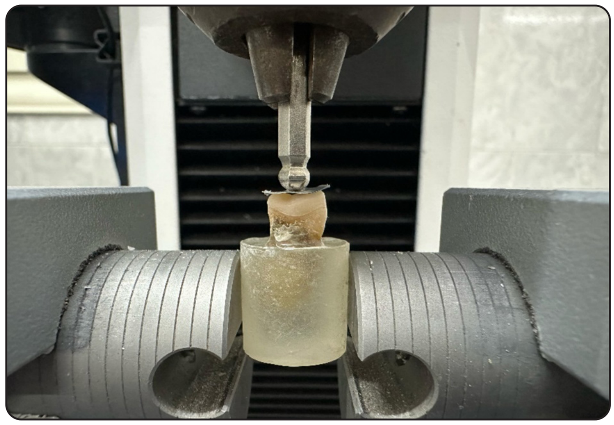

Fig. (3). Fracture resistance test using Instron testing machine

Failure mode

Following the fracture resistance test, the samples in both groups were viewed using USB digital-microscope (Nikon SMZ745T Stereomicroscope, Japan), and the images were captured using a digital camera (25EOS 650D, Canon, Japan) with 3 Mega Pixels of resolution, placed vertically at a distance of 2.5 cm from the samples. The angle between the axis of the lens and the sources of illumination is approximately 90 degrees. Illumination was achieved with 8 LED lamps (Adjustable by Control Wheel), with a color index close to 95 % (20).

The images were taken at maximum resolution and connected with compatible personal computer using a fixed magnification of 35X.The resolution of the recorded images was set at 1280×1024 pixels and transferred to a personal computer equipped with the Image-tool software (26Image J 1.43U, National Institute of Health, USA)

Statistical Analysis

Data was recorded in mean and standard deviation (SD) values. Data explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Fracture resistance (N) showed a parametric distribution, so two-way ANOVA used to study the effect of restoration material and preparation followed by Tukay's post-hoc test for pairwise comparison when ANOVA is significant. Fisher exact test was performed for failure mode analysis.

The level of significance was set at $P \leq 0.05$ while the levels of power and confidence were set at 80% and 95% respectively. Statistical analysis was performed with IBM® SPSS® (SPSS Inc., IBM Corporation, NY, USA) statistics version 26 for Windows.

RESULTS

Fracture resistance

It was discovered that group B1 recorded the highest statistically significant fracture resistance (1468.268±353.88N) and the lowest group was R2

(749.648±104.87N). While there is no statistically significant difference between B2, R1 and R2 as illustrated in Table 3 and Fig. 4.

Regarding the preparation design effect regardless the selected material, group 1 recorded statistical significant difference (mean value= 1164.15± 403.87N) than group 2 mean value= 833.60± 124.67N) where P-value=0.024. While regarding the effect of the material selected regardless the preparation design, the difference between group B (mean value=1192.9±377.79N) and group R (mean value=804.839±113.86N) was statistically significant where P-value=0.006.

Failure mode

All reinforced composite occlusal veneers either in group 1 or 2 showed favorable failure mode (100%) which represents fracture of the restoration without damage to underlying tooth structure. Meanwhile for lithium disilicate occlusal veneers, 5 samples showed catastrophic failure mode; one sample in group 1 and four samples in group 2. Distribution of failure modes scores for both materials is shown in Table 4 and Fig. 5.

The difference between failure modes of the 2 selected materials is statistically significant where P-value = 0.0325. Meanwhile there is no statistical significant difference between the 2 preparation designs where P-value = 0.303.

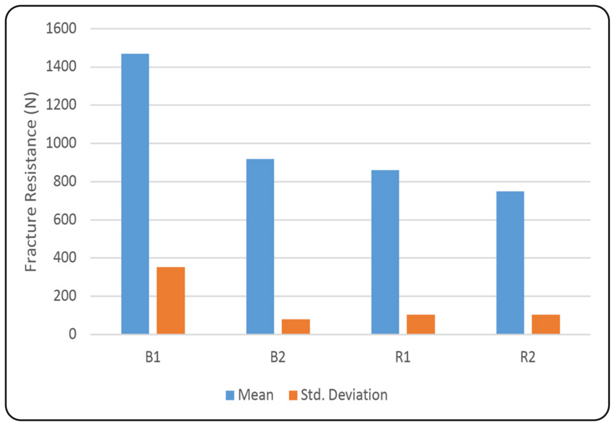

Fig. (4). Bar chart representing mean fracture resistance (N) for different tested groups

TABLE (3). The results of fracture resistance test

Groups	Mean	Std. Deviation	Lower 95% CI of mean	Upper 95% CI of mean
B1	1468.268	353.88	1282.765	1653.770
B2	917.548	79.72	732.046	1103.050
R1	860.03	102.76	674.532	1045.536
R2	749.648	104.87	564.145	935.150

Table (4). The failure mode

CAD/CAM material	Preparation Design	Failure mode	
		Favorable	Catastrophic
Brilliant Crios	With chamfer finish line	100%	0%
	Without chamfer finish line	100%	0%
Rosetta SM	With chamfer finish line	80%	20%
	Without chamfer finish line	20%	80%

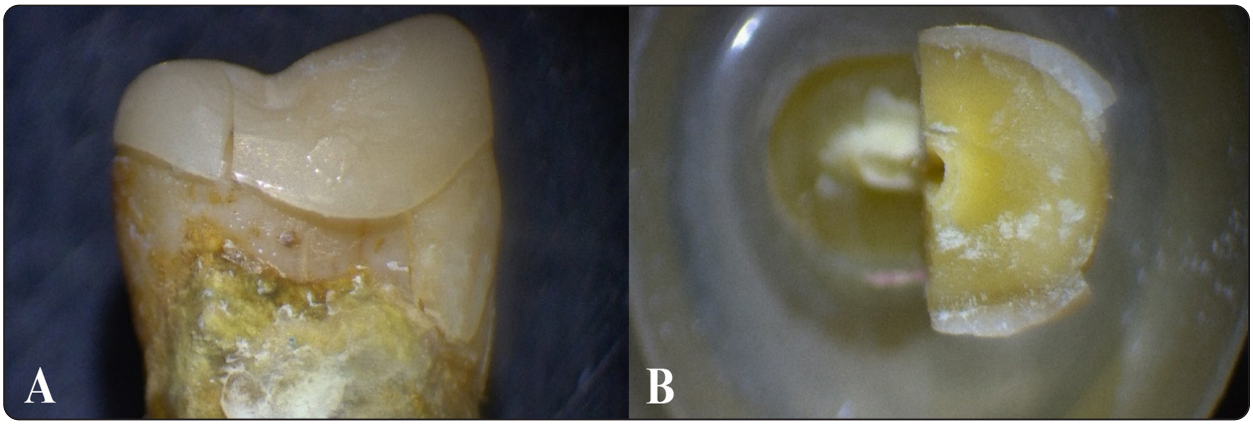

Fig. (5) Failure modes A) Favorable B) Catastrophic

DISCUSSION

Occlusal veneers are considered one of the recent conservative approaches for management of worn dentition[21] as they are considered thin overlays gaining retention through adhesion to tooth surface restorations therefore preserving coronal structure and avoiding the root canal treatment.[22]

In the present study occlusal veneers with 1.2mm thickness were used based on findings by a previous study[4] who showed that the average value of fracture strength for posterior restorations ranges from 500 to 700 N that were exceeded by the strength values of the 0.7 and 1.0 mm glass ceramic occlusal veneers.

In order to simulate the intra-oral conditions, natural teeth were selected to receive the occlusal veneers which are better than epoxy dies regarding bonding mechanism and modulus of elasticity. All the natural teeth used in this study were lower premolars with similar dimensions to avoid change in the surface area which have an effect on the fracture resistance.[23] In addition thermocycling was done for 3000 cycles between 5^{o}c and 55^{o}c.

The design of preparation is a crucial factor that can influence the fracture resistance and marginal adaption of indirect restorations. Planar preparation design of occlusal veneers is more preferred as a conservative strategy in worn dentition situations over the years. Recently, some modifications was suggested to this design through cuspal coverage to improve the performance of occlusal veneers.[24] So in our study, the effect of preparation design on the fracture resistance and mode of failure of occlusal veneers was investigated.

In this study, two occlusal veneers preparation designs were selected; planar occlusal reduction only which is considered a more conservative and minimally invasive design which was confirmed by many authors.[25,26] However, adding a circumferential chamfer finish line provides positive points in seating, support and easier milling more than the conventional planar design.[5]

Selecting the right material is crucial for a successful occlusal veneer in teeth that have lost a significant amount of structure due to wear.[27] The choice of Rosetta SM blocks was based on previous studies which supports their use in all lithium disilicate material application**.**[28] While selection of Brilliant Crios blocks since this innovative reinforce composite blocks ensures a unique balance between strength and elasticity which provides high rate of masticatory force absorption. It also has superior milling properties and reduces tool wear.

Regarding the material effect, it was found that reinforced composite occlusal veneers have significantly higher mean fracture resistance

(1192.9N) than lithium disilicate occlusal veneers (804.839) with P-value = 0.006. This may be referred to the lower elastic modulus of CAD/CAM reinforced composite and its enhanced resilience, which allows for greater load absorption during utilization. Furthermore, the incorporation of polymers within its microstructure enhances its resistance to fracture propagation in comparison to lithium disilicate group. The elastic modulus, comparable to that of dentine, is proposed to reduce stress concentration in the restoration and prevent fracture. Moreover, the chemical composition of reinforced composite blocks give elasticity to withstand forces applied to the tooth.[17,29] However, a previous study recorded a lower value of fracture resistance for hybrid ceramic compared to lithium disilicate occlusal veneers. This may be attributed to the different type of tooth or different bonding technique.[26]

While regarding the effect of the preparation design, it was found that the chamfer finish line group 1 recorded significantly higher mean value (Mean=1164.15 N) than planar preparation without chamfer finish line group 2 (Mean=833.6 N) with P-value=0.024. This led to the rejection of the study's null hypothesis that there would be no difference in fracture resistance between the two preparation designs. This significant difference may be explained by the larger surface area covered in group 1 which leads to more stress distribution on the tooth structure. In agreement with our study, many authors showed that milled lithium disilicate occlusal veneers with a circumferential chamfer finish line demonstrated promising fracture resistance compared to that of a traditional conservative preparation.[21,22,30]

On the other hand, some studies found that limiting the occlusal veneer preparation to the occlusal surface without a finish line extension would decrease the internal stresses of the restoration .They also demonstrated that stress -bearing zones might be created at the cusp tips beneath the thin occlusal veneer when the axial walls were prepared with a finish line across them.[31,32,33] In two systematic reviews based on invitro studies, reported that various preparation designs had no bearing on fracture resistance of bonded posterior occlusal veneers. Also some authors found comparable results between lithium disilicate and hybrid ceramic occlusal veneers.[7,34]

The normal masticatory forces in premolar region ranges from 450N and may be increased to 660N in case of parafunctional habits.[35] In the current study, the mean values of fracture resistance for all occlusal veneer restorations exceeded the individual biting forces so they can be clinically used in the premolar region with favorable expected prognosis. This may be explained by the strong adhesive bonding between the tooth surface and occlusal veneers.[26]

Regarding the failure modes, 50% of lithium disilicate occlusal veneers showed catastrophic failure including both the restoration and the tooth mostly in group 2 without a circumferential chamfer finish line. This might be due to less surface area leading to more stress concentration on tooth structure leading to that catastrophic failure.[36] Moreover, the higher modulus of elasticity of lithium disilicate may lead to transmission of forces through restoration-tooth complex [24,37] which spreads to tooth structure leading that catastraphoic failure.[38] A previous study found that the amount of stresses within lithium disilicate occlusal veneer was 1.5 times higher than for hybrid ceramic occlusal veneer.[39] While all the reinforced composite occlusal veneers showed favorable failure including only the restoration which means it is repairable or can be replaced by a new restoration without damage to the underlying tooth structure. This may be due to the monoblock effect between the composite veneers and dentin achieved through strong bonding and comparable modulus of elasticity leading to better stress distribution and less stress transmitted through tooth structure.[40]

The conflict between the different authors as far as fracture resistance of occlusal veneers may be considered not unusual looking to the different circumstances under which these researches were undertaken. Considering the teeth to be prepared, whether natural or artificial, the preparation designs and accuracy of their standardization, the materials tested, the nature of bonding mechanism and the type of mechanical testing whether static or cycling. All these might justify this difference of opinions and must also be taken into consideration as limiting factors in this kind of researches.

Limitations:

The simulation of masticatory forces was restricted to a particular angle, making the direct application of this study's findings to a clinical context problematic, as is often the case with other in vitro studies. Furthermore, because to the in vitro nature of this model, the lack of periodontal ligament is apparent, and it is crucial to recognize that these results do not clarify the response of soft tissue to various restoration or preparation types.

Conclusion:

Within the limitation of our study:

1- Reinforced composite occlusal veneers exhibited better fracture resistance and favorable failure characteristics in comparison with lithium disilicate occlusal veneers.

2- The planar preparation with a circumferential chamfer finish line yields superior outcomes compared to the group without a chamfer finish line.

3- Occlusal veneers in the premolar region can withstand intraoral masticatory forces as all fracture resistance loads exceeded the maximum masticatory forces.

RECOMMENDATION

Within the limitation of our study:

1. Future research including various methodologies for simulating the oral environment is recommended.
2. Clinical investigations of various occlusal veneers preparation and materials for premolars are recommended.

REFERENCES

1. Laghzaoui S, Chafii A, Maftouh B, Matoui E, Bennani S. Inlay, Onlay: Indication and Principle of Preparation. Stech-nolock J Dent. 2021;1:1-9.
2. Elmoselhy HAS, Hassanien OES, Haridy MF, Salam El Baz MAE, Saber S. Two-year clinical performance of indirect restorations fabricated from CAD/CAM nano hybrid composite versus lithium disilicate in mutilated vital teeth. A randomized controlled trial. BMC Oral Health. 2024;24(1):101.
3. Abrahamsen TC. The worn dentition—pathognomonic patterns of abrasion and erosion. International dental journal. 2005;55(S4):268-76.
4. Sasse M, Krummel A, Klosa K, Kern M. Influence of restoration thickness and dental bonding surface on the fracture resistance of full-coverage occlusal veneers made from lithium disilicate ceramic. Dental Materials. 2015;31(8):907-15.
5. Shalaby MM, Abo-Eittah MR. Influence of the preparation design and aging on the vertical marginal gap of occlusal veneers constructed of different ceramic materials. Egyptian Dental Journal. 2020;66(2-April (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)):1261-74.
6. Nandini S. Indirect resin composites. Journal of Conservative Dentistry. 2010;13(4):184-94.
7. Beji Vijayakumar J, Varadan P, Balaji L, Rajan M, Kalaiselvam R, Saeralaathan S, et al. Fracture resistance of resin based and lithium disilicate endocrowns. Which is better?–A systematic review of in-vitro studies. Biomaterial Investigations in Dentistry. 2021;8(1):104-11.
8. Ibrahim SH, Amr H, Hassan AA, Elzohairy A. Internal fit evaluation of indirect restorations fabricated from

CAD/CAM composite blocks versus ceramic blocks in badly broken teeth using cone beam CT (CBCT): double-blinded randomized clinical trial. Heliyon. 2022;8(5).

9. Elsharkawy A. Marginal Adaptation And Fracture Resistance of Endocrown Restorations Constructed From Two CAD/CAM Blocks. Egyptian Dental Journal. 2021; 67(4):3547-60.

10. Abed Y, Elkorashy M. Fracture resistance and failure mode of composite Endocrowns for maxillary premolars: new restorative approaches. Egyptian Dental Journal. 2022;68(1):1053-63.

11. Prasanth V, Harshakumar K, Lylajam S, Chandrasekharan Nair K, Sreelal T. Relation between fracture load and tooth preparation of ceramic veneers-an in vitro study. Health Sciences. 2013;2(3):1-11.

12. Aqlan S, Kheiralla L. Fracture resistance of thin occlusal veneers made from hybrid ceramic (Cerasmart)-In vitro study. Al-Azhar Journal of Dental Science. 2018; 21(3):293-7.

13. Jayna M, Jayna A, Yadav B, Dabas N. Clinical insight into tooth preparation: An update. The Saint's International Dental Journal. 2015;1(1):2-7.

14. Sha'aban AM, El Naggar GA, Nabil R, Rashad MA, Attia YS. Wear assessment of current aesthetic crowns compared with human enamel after two finishing procedures: In vitro study. F1000Research. 2019;8:1115.

15. Çakmak G, Donmez MB, de Paula MS, Akay C, Fonseca M, Kahveci Ç, et al. Surface roughness, optical properties, and microhardness of additively and subtractively manufactured CAD/CAM materials after brushing and coffee thermal cycling. Journal of Prosthodontics. 2023.

16. Fathy H, Hamama HH, El-Wassefy N, Mahmoud SH. Effect of different surface treatments on resin-matrix CAD/CAM ceramics bonding to dentin: in vitro study. BMC Oral Health. 2022;22(1):635.

17. El Zohairy A, Hafez A, Amr H. Repair potentiality of CAD/CAM composite block and hybrid ceramic block by direct resin composite restoration with and without surface treatment. Egyptian Dental Journal. 2019;65(Issue 1 - January (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)):551-62.

18. Vasiliu R-D, Porojan SD, Bîrdeanu MI, Porojan L. Effect of Thermocycling, Surface Treatments and Microstructure on the Optical Properties and Roughness of CAD-CAM and Heat-Pressed Glass Ceramics. Materials. 2020;13(2):381.

19. Mosallam RS, Haridy MF. Fracture Strength of Endodontically Treated Teeth Restored with Endocrown restorations with /without Resin Composite Base Materials – An in vitro study. Egyptian Dental Journal. 2019;65 (Issue 3 - July (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)):2837-48.

20. Elsharkawy A. Fracture Resistance Of Endodontically Treated Premolars Restored With Endocrowns With Different Preparation Depth. In Vitro Study. Egyptian Dental Journal. 2021;67(3):2465-74.

21. Halim CH. Fracture resistance of a newly proposed occlusal veneer design using two different CAD/CAM ceramic materials. Egyptian Dental Journal. 2018;64(3-July (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)):2899-915.

22. Angerame D, De Biasi M, Agostinetto M, Franzò A, Marchesi G. Influence of preparation designs on marginal adaptation and failure load of full-coverage occlusal veneers after thermomechanical aging simulation. Journal of Esthetic and Restorative Dentistry. 2019;31(3):280-9.

23. Emam, Z., & A. Aleem, N. (2020). Influence of Different Materials and Preparation Designs on Marginal Adaptation and Fracture Resistance of CAD/CAM Fabricated Occlusal Veneers. *Egyptian Dental Journal*, *66*(Issue 1 - January (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)), 439-452. doi: 10.21608/edj.2020.79120

24. Kotb S, Shaker A, Halim C. Fatigue resistance and 3D finite element analysis of machine-milled ceramic occlusal veneers with new preparation designs versus conventional design: an in vitro study. F1000Research. 2019;8:1038.

25. Magne P. Immediate dentin sealing: a fundamental procedure for indirect bonded restorations. Journal of Esthetic and Restorative Dentistry. 2005;17(3):144-54.

26. Al-Akhali M, Chaar MS, Elsayed A, Samran A, Kern M. Fracture resistance of ceramic and polymer-based occlusal veneer restorations. Journal of the mechanical behavior of biomedical materials. 2017;74:245-50.

27. Schlichting LH, Resende TH, Reis KR, Dos Santos AR, Correa IC, Magne P. Ultrathin CAD-CAM glass-ceramic and composite resin occlusal veneers for the treatment of severe dental erosion: An up to 3-year randomized clinical trial. The Journal of prosthetic dentistry. 2022;128(2):158.e1-. e12.

28. Kang S-H, Chang J, Son H-H. Flexural strength and microstructure of two lithium disilicate glass ceramics for CAD/CAM restoration in the dental clinic. Restorative dentistry & endodontics. 2013;38(3):134-40.

29. Rizk A, El-Guindy J, Abdou A, Ashraf R, Kusumasari C, Eldin FE. Marginal adaptation and fracture resistance of virgilite-based occlusal veneers with varying thickness. BMC Oral Health. 2024;24(1).

30. Hassan SM, El Mekkawi W. Influence of different preparation designs on fracture resistance of full-coverage occlusal veneers after thermo-mechanical aging simulation. Al-Azhar Assiut Dental Journal. 2020;3(2):145-54.

31. Huang X, Zou L, Yao R, Wu S, Li Y. Effect of preparation design on the fracture behavior of ceramic occlusal veneers in maxillary premolars. Journal of Dentistry. 2020;97:103346.

32. Zhang H, Lv P, Du W, Jiang T. Comparison of fracture load and surface wear of microhybrid composite and ceramic occlusal veneers. Journal of Prosthodontics. 2020;29(5):387-93.

33. Al-Zordk W, Saudi A, Abdelkader A, Taher M, Ghazy M. Fracture Resistance and Failure Mode of Mandibular Molar Restored by Occlusal Veneer: Effect of Material Type and Dental Bonding Surface. Materials (Basel). 2021;14(21).

34. Mohamed K, El Mahallawi O, Zaki A. In-vitro fatigue resistance of bonded posterior occlusal veneers: a systematic review. Indian J Sci Technol. 2016;9(34):1-8.

35. WIDMALM SE, Ericsson SG. Maximal bite force with centric and eccentric load. Journal of Oral Rehabilitation. 1982;9(5):445-50.

36. Krummel A, Garling A, Sasse M, Kern M. Influence of bonding surface and bonding methods on the fracture resistance and survival rate of full-coverage occlusal veneers made from lithium disilicate ceramic after cyclic loading. Dental Materials. 2019;35(10):1351-9.

37. Cardoso M, de Almeida Neves A, Mine A, Coutinho E, Van Landuyt K, De Munck J, et al. Current aspects on bonding effectiveness and stability in adhesive dentistry. Australian dental journal. 2011;56:31-44.

38. Kwon SJ, Lawson NC, McLaren EE, Nejat AH, Burgess JO. Comparison of the mechanical properties of translucent zirconia and lithium disilicate. The Journal of prosthetic dentistry. 2018;120(1):132-7.

39. Huang X-q, Hong N-r, Zou L-y, Wu S-y, Li Y. Estimation of stress distribution and risk of failure for maxillary premolar restored by occlusal veneer with different CAD/CAM materials and preparation designs. Clinical Oral Investigations. 2020;24:3157-67.

40. Wang J, Ling Z, Zheng Z, Zheng C, Gai Y, Zeng Y, et al. Clinical efficacy of ceramic versus resin-based composite endocrowns in Chinese adults: study protocol for a randomized controlled trial. Trials. 2020;21(1):559.