EFFECT OF POSTERIOR VENEER PREPARATION DESIGN ON FAILURE LOAD AND MODE BEFORE AND AFTER FATIGUE

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ABSTRACT

INTRODUCTION: Ceramic veneers play a vital role in dental aesthetics, providing accurate and efficient restoration of tooth shape, color, contour, and the function. The preparation design is a crucial determinant for the veneer success, as it significantly affects their resistance to failure and overall longevity, especially in minimally invasive for posterior teeth ceramic restorations.

OBJECTIVES: To evaluate the buccal cusp reduction and mesio-occluso-distal (MOD) box preparation designs effect on the fatigue survival and the failure load of minimally invasive posterior ceramic veneer restorations.

MATERIALS AND METHODS: Twenty human maxillary premolars were assigned into two groups each of ten. Control group with intact unprepared premolars. Study group: premolars were prepared with a depth of 0.7 mm for buccal preparation, buccal cusp reduction, and MOD box preparation. Restorations with Monolithic lithium disilicate were adhesively cemented then subjected to cyclic mechanical loading and thermocycling simultaneously. All specimens were exposed to "single load-to-failure". The difference between failure load before and after fatigue was calculated, and stress at failure was calculated using fractography.

RESULTS: The Fracture Resistance shows no notable difference between the two groups examined, both prior to and following fatigue testing. Nonetheless, the reduction in fracture resistance percentage was statistically significantly less in the MOD group compared to the control group. In the MOD group the main failure mode was type II, accounting for 60% of the specimens.

CONCLUSION: Preparation designs with minimally invasive non-retentive with MOD demonstrated satisfactory fatigue and fracture resistance, supporting the need for further clinical research.

KEYWORDS: Mesio Occluso Distal Box - Buccal Cusp Reduction - Posterior Veneer Preparation Designs - Load and Mode After Fatigue

RUNNING TITLE: Effect of Buccal Cusp Reduction and Mesio Occluso Distal Box Preparations in Posterior Veneer Preparation Designs on Failure Load and Mode After Fatigue

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INTRODUCTION

Maintaining natural tooth structure is a fundamental objective in restorative dentistry. The durability and success of restorations depend on choosing the right materials and preserving the integrity of the natural tooth.(1) Nonetheless, the natural contacts between the upper and lower of teeth can diminish due to wear, decay, or misalignment. Managing these issues is complex and challenging, as traditional restorative materials often necessitate the removal of healthy tooth structure.(2,3)

Teeth with Mesial-Occluso-Distal (MOD) cavities frequently undergo substantial structural loss due to decay or deteriorating restorations, increasing their susceptibility to fractures compared to intact teeth.(4) The restoration fracture resistance is greatly affected by the amount of tooth structure that remains after cavity preparation.(5) Large cavity preparations in MOD cavities can weaken the cusps or roots of posterior teeth, decreasing their fracture resistance by as much as 54% compared to teeth that have not been prepared.(6) Different cavity preparation techniques, including those with or without a proximal box, are employed for MOD cavities.(4)

Teeth with extensive MOD cavities undergo considerable weakening because of the absence of supportive elements, like the marginal ridge, rendering them more prone to fractures.(7) Restoring these preparations with adhesive materials can result in a partial or full restoration of fracture resistance.(8,9)

Additionally, it is widely recognized that teeth that have undergone endodontically treatment are prone to fractures. The role of adhesive restorations in strengthening the residual dental tissue and the deterioration of tooth structure brought on by MOD preparations have both been examined in recent studies.(10) As more dental tissue is eliminated, a tooth's strength declines, particularly when it comes to the vestibule-palatal width of the occlusal box preparation.(11)

VOnlay is a unique concept that combines an Onlay with an extended buccal veneer. It is specifically designed for usage in bicuspid regions rather than for full-coverage restorations (12).

Endodontically treated teeth (ETT) with MOD preparations are particularly prone to fractures. Moreover, ETT typically withstand higher occlusal forces before eliciting pain responses that signal load reduction, increasing their risk of structural failure. After a cuspal reduction of roughly 1.5 to 2 mm, experts advise employing bonded indirect Onlays to improve fracture resistance and protect the remaining tooth structure in severe MOD cavities.(13)

Fracture resistance maximization, is crucial for extending the lifespan of conservative dental restorations. Products with improved fracture resistance have been introduced as a result of recent advancements in dental materials. Additionally, dental professionals are now able to use more conservative restoration procedures thanks to advancements in the mechanical, physical, and optical characteristics of bonding systems.(14)

Although indirect restorations are traditionally regarded as the gold standard for managing large defects, recent clinical trials have assessed the direct use of composite resins for extensive cavity restorations, demonstrating promising results.(15)

ETPs are treated using a variety of restorative methods and materials, such as post and core systems, complete or partial crowns, materials like amalgam or ceramics and direct composite resin. Glass fiber posts are particularly preferred due to their advantageous physical properties in reinforcing ETPs. It has been discovered that placing glass fiber posts horizontally in MOD cavities that have been repaired with composite resin improves the teeth's resistance to fracture.(16)

ETPs can be restored with ceramic restorations. Fluorescence, chemical stability, Translucency, high compressive strength, biocompatibility, and a thermal expansion coefficient similar to that of natural tooth structure are just a few advantages offered by ceramics. Ceramics are more prone to fracture because of their relative fragility under tensile and occlusal stresses, notwithstanding their beneficial qualities. This tendency to fracture is a crucial factor in clinical decision-making when selecting restorative materials for ETPs.

With the advent of CAD-CAM technology in dentistry, the usage of all-ceramic restorations has increased significantly. Although they are sometimes very opaque, ceramic materials with a high crystalline content usually exhibit exceptional fracture resistance. The framework material is typically veneered with porcelain for a more realistic-looking repair, which improves aesthetics. Veneer and framework materials' mechanical performance has historically been examined separately, offering important information on each restoration component's resistance to fracture. However, understanding the interaction between these materials when layered in a restoration is equally important.Analyzing layered structures provides important information on thermal stresses, interfacial bonding, failure modes and origins, and stress distribution.

In applications like as anterior veneers, posterior Onlays, and inlays, in addition to crown restorations, lithium disilicate (LDS) glass-ceramic, which is made using press or CAD/CAM processes, has shown exceptional long-term clinical survival and success rates.(17-19) The suggested thickness for adhesively cemented LDS crown restorations has been reduced by manufacturers to one mm as a result of these positive outcomes.(20)

LDS occlusal veneers, also referred to as table tops, have been used for molars in more recent times. The non-retentive nature of these ultra-thin Onlays makes them a more conservative option than full-coverage crowns.(21,22) The existing clinical and in vitro data for defect-oriented preparation designs, e.g. posterior full-veneer restorations with decreased thickness, are still scarce.(23) In clinical practice, LDS demonstrates a high survival rate in posterior teeth.(24). Compared to ceramic blocks, resin composite blocks offer a number of benefits, such as greater bind strength to resin-based adhesive materials and simpler milling, adjustment, and repair.(25)

Nevertheless, there is currently a dearth of thorough information regarding the choice of appropriate tooth-colored restorative materials and how they affect the ability of restorations to withstand fracture in different kinds of cavities.(4)

MATERIALS AND METHODS

Twenty human extracted maxillary premolars were obtained from the outpatient clinic of the Oral Surgery Department at the Faculty of Dentistry, Alexandria University. The teeth were extracted for orthodontic reasons. The study was conducted following approval from the ethical committee of the Faculty of Dentistry, Alexandria University, Egypt. The following materials were used in the study; Silicone impression material, lithium disilicate glass–ceramic (IPS e.max CAD), 9% hydrofluoric acid Silane coupling agent, Bonding agent Tetric N universal bond, Phosphoric acid at 37%, and Adhesive resin cement Variolink II. The equipment were; Diamond burs veneers preparation kit, CAD/CAM Milling machine, Mastication simulator, Universal testing machine Optical microscope and Laboratory scanner.

Methods:

Specimen preparation

Twenty human maxillary premolars were extracted for medical use. These teeth were kept at room temperature in a 0.1% thymol solution since they were free of cavities, fractures, and restorations.(14)

Two equal (n=10) test groups were assigned randomly. Sound, unprepared premolars comprised the Control Group, whereas premolars prepared using MOD box preparation, buccal cusp reduction of 1.5 mm, following the cuspal contour, and a 0.7 mm deep buccal preparation using diamond depth cutting bur and round-end tapered diamond at speed of 300,000 RPM, and the MOD Group using a set of burs including: 330 Dental Carbide Bur for preparing the occlusal outline, 245 Dental Carbide Bur for preparing the proximal box, 847KR-016 Dental Diamond Bur tapered flat end medium grit for preparing shoulder finish lines, and KS-0 Round-End Parallel Dental Diamond Bur medium grit for preparing incisal, occlusal and axial wall. The dimensions of the occlusal box preparation were two mm in width and three mm in depth. The occlusal portion follows the central grooves and extends into the mesial and distal pits. The occlusal outline is rectangular.

The proximal box preparation measured three mm in width from the buccal to the palatal wall and 1.5 mm in depth from the pulpal wall to the cervical wall. The shape of proximal box is rectangular in cross-section. The gingival floor is flat and perpendicular to the long axis of the tooth. The internal line angles of the boxes are rounded to reduce stress concentration.

One millimeter above the cementoenamel junction was the finish line for the mesial and distal boxes (Figure 1).(26)

Before preparation, all teeth were embedded in a self-curing resin. Silicone impression index (***3M*** ESPE Vinyl Polysiloxane (VPS) of each tooth was made, and sectioned in a buccolingual direction to control tooth substance removal. The depth of the preparation was verified with silicone keys.

Every tooth was firmly set in self-curing resin. In order to track the removal of tooth substance, a silicone impression index of each tooth was made using 3M ESPE Vinyl Polysiloxane prior to preparation and sectioned in a buccolingual direction. Using a Microdont diamond bur veneer preparation kit, at 300,000 RPM and used an air-water spray for cooling, the procedure was completed. A chamfer finish line extended slightly into the inter-proximal area without completely breaking the contact. The finish line matched the necessary thickness and maintained a depth of 0.5 mm was applied to the labial surface.(16) The finish line was one millimeter above the cementoenamel junction for the mesial and distal boxes. The preparation depth was verified with silicone keys, and all interior cavity borders and preparation angles were meticulously rounded.

A dental laboratory scanner (Medit i710) digitized the prepared teeth to capture digital impressions. The teeth were sprayed (Cerec optispray) to improve the precision of the digital impression. The precision of the scan ensures the generation of a faultless digital representation of the tooth.

A Computer-Aided Design (CAD) software (Exocad, Exocad GmbH in Darmstadt, Germany) was utilized to design the lithium disilicate restorations (IPS e.max CAD, Ivoclar Vivadent in Schaan, Liechtenstein). The design was sent to CAM milling equipment (CEREC 3, Sirona Dental Systems, GmbH in Bensheim, Germany). Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) (CAD-CAM) blocks, A3 in the shade and C14 in size were inserted into the machine and subjected to wet milling followed by crystallization heat treatment for 20 to 25 minutes, at 850 to 880 ºC (Programmat P310, Ivoclar Vivadent, Schaan, Liechtenstein).

The inside surfaces of the restorations were etched for 20 seconds using 9% hydrofluoric acid (Ceramic Etchant; Ultradent, USA) before being thoroughly cleaned with an oil-free air-water spray and allowed to air dry before adhesive cementation. The ceramic surface was carefully treated with a silane coupling agent (Ultradent, USA) by applying a thin layer of silane coupling agent to the etched ceramic surface using a microbrush, which allows the silane to react for at least 60 seconds. Then gently drying the surface to remove excess solvent, ensuring a thin and even layer. After silane application, air drying gently for 10–20 seconds is done to allow solvent evaporation. The surface should appear glossy, indicating successful silanization.

For 30 seconds on enamel and 15 seconds on dentin, a 37% phosphoric acid solution (Total Etch; Ivoclar Vivadent) was administered. The surfaces were then carefully cleaned with water and allowed to air dry. A bonding agent (Ivoclar Vivadent; Tetric N-Bond Universal) was then applied to the tooth surface using a disposable micro bruches, then gently scrubing the bonding agent for 10–20 seconds. Gentle oil-free air drying for 5–10 seconds to evaporate solvents, then light curing with an LED light for 20 seconds.

After applying a dual-cure adhesive resin cement (Variolink-II, Ivoclar Vivadent), the excess cement was carefully scraped off. After seating the veneer, the gross excess cement was gently removed using a microbrush or an explorer. Then, Pre-Curing "Tack Cure," Lightly cure the margins for 1–3 seconds per tooth using an LED curing light (Light intensity 1500 mW/cm²) at 2 mm distance from the tooth. Once the cement reaches a rubbery consistency, use a scaler or explorer to lift off the excess from the margins. For interproximal excess, dental floss (unwaxed or PTFE floss) was used with a gentle sawing motion to clear cement from contacts. Once excess cement is removed, the final light curing was performed: Buccal/Labial surface: 20–40 seconds; Interproximal and Lingual (if accessible): 10–20 seconds per side.

Using a mastication simulator, all specimens were subjected to simultaneous thermocycling (5–55°C) and cyclic mechanical loading. 50,000 cycles were performed with a load between 50 and 100 N.(16) The central fissure was subjected to cyclic fatigue, which applied force along the palatal cusp in order to mimic natural mastication. During the fatigue testing procedure, specimens were closely inspected for any indications of debonding, cracks, or fractures.

All specimens were subjected to single load-to-failure (SLF) testing utilizing a universal testing machine (5 ST, Tinius Olsen, England, 2018) (Figure 2) after fatigue testing. The load was applied using a six mm diameter steel ball at a crosshead speed of 1.5 mm/min.

The load is applied **perpendicular (90°) to the veneer's surface** to mimic masticatory forces. The steel ball (6 mm diameter) is placed at the center of the occlusal surface, making contact with the central fossa or cusp inclines.

To guarantee uniformity, each specimen was axially loaded at the same contact point as in the fatigue simulation. Axial loading was applied to each specimen until fracture, and the maximum load-to-failure was noted and examined with the aid of specialized software.

The fractured surfaces were examined under a light stereomicroscope (SZ1145TR, Olympus, Japan, 1990) (Figure 3) at 5x and 10x magnification for visual assessment.

The failure modes were classified as follows: (I) Crack formation within the ceramic, (II) Cohesive fracture within the ceramic while the tooth remained intact, (III) Fracture involving both the ceramic and tooth structures, and (IV) Severe or longitudinal fractures affecting both the ceramic and tooth, extending into the root (Figure 4).(27).

A Scanning Electron Microscope (SEM) (Magnification power 500x) was used to evaluate the type and origin of the fracture. The size of the propagating crack has a significant impact on the fracture strength of brittle ceramics, according to the literature.(28). Larger structural defects result in lower failure stress for the same material, whereas smaller defects result in higher failure stress. The following formula can be used to numerically express this relationship:

$$\sigma = \frac{K}{Y\sqrt{a}}$$

where σ is the failure stress, K the fracture toughness of the material, Y the geometric constant, and (a) is the depth the critical crack.

Statistical analysis

The gathered data underwent statistical analysis using version 25 of the Statistical Package for the Social Sciences (SPSS) program [10]. The data were described using descriptors such as minimum, maximum, mean, standard deviation, standard error of the mean, and a 95% confidence interval (CI) for the mean(29). A 20% margin of error (beta error) was considered acceptable to maintain a study power of 80% when establishing the sample size. The significance level (alpha) was 5%, representing a 95% confidence level. Statistical significance was determined with a *p*-value less than .05(30).

Figure (1): Buccal surface preparation with occlusal surface of the buccal cusp and MOD box preparation.

Figure (2): Universal testing machine (5 ST, Tinius Olsen England 2018)

Figure (3): Light stereomicroscope with 5 and 10 folds of magnification (SZ1145TR, Olympus, Japan, 1990)

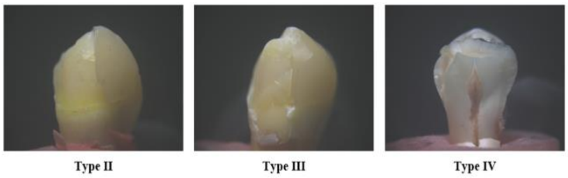

Figure (4): Different modes of failure

RESULTS

(data are presented as median, 95% Confidence Interval of the Median and 25th Percentile – 75th Percentile)

Fracture Resistance (Table 1)

Before Fatigue:

In the Control Group: the Fracture Resistance ranged from 987.24 to 1410.69 N, with a median of 1200.53, a 95% Confidence Interval (CI) median of 1156.23-1245.32 and 25th – 75th Percentile of 1156.23-1245.32 N.

In the MOD Group, the Fracture Resistance ranged from 1011.65 to 1402.30 N, with a median of 1294.11, a 95% CI of the median of 1243.45-1342.50, and 25th – 75th Percentile of 1243.45-1342.50 N.

Prior to fatigue, there is no statistically significant difference in the fracture resistance between the two groups under study (*p*=.151).

After Fatigue:

In the Control Group: the Fracture Resistance ranged from 870.23 to 1236.47 N, with a median of 1037.26, a 95% CI of the median of 987.72-1198.78 and 25th – 75th Percentile of 987.72-1198.78 N.

In the MOD Group: the Fracture Resistance ranged from 979.15 to 1389.25 N, with a median of 1200.41, a 95% CI of the median of 1168.23-1295.47, and 25th – 75th Percentile of 1168.23-1295.47 N.

Following fatigue, there is no statistically significant difference in fracture resistance between the two groups under study (*p*=.096)

The Fracture Resistance statistically significantly decreased after fatigue compared with before fatigue in the Control and MOD Group (*p*=.012, *p*=.012, *p*=.005 and *p*=.005, respectively) (Figure 5)

Percentage Change (%):

In the Control Group: the Fracture Resistance percentage change ranged from -17.04 to -1.14 %, with a median of -12.53%, a 95% CI of median of -14.46 - -6.23and 25th – 75th Percentile of -14.46 - -6.23%.

In the MOD Group: the Fracture Resistance percentage change ranged from -10.10 to -0.93 %, with a median of -4.44%, a 95% CI of the median of -8.01 - -3.21, and 25th – 75th Percentile of -8.01 - -3.21%.

The Fracture Resistance percentage decrease was statistically significantly lower in the MOD Group in comparison with the control groups (*p*=.028) (Figure 6).

Failure Mode:

In the MOD Group; 6/10 (60.00%) was Type II failure, 2/10 (20.00%) Type III failure and 2/10 (20.00%) Type IV failure. The predominant failure mode was type II, characterized by cohesive fracture inside the ceramic material while keeping the tooth intact. This kind of failure occurred in 60% of cases in MOD group.

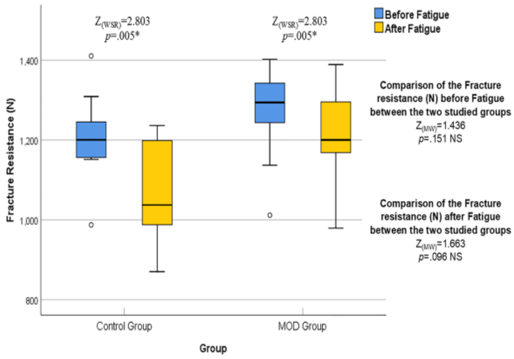

Figure (5): Box and whisker graph of Fracture Resistance (N) in the studied groups, the thick line in the middle of the box represents the median, the box represents the inter-quartile range (from 25th to 75th percentiles), the whiskers represent the minimum and maximum.

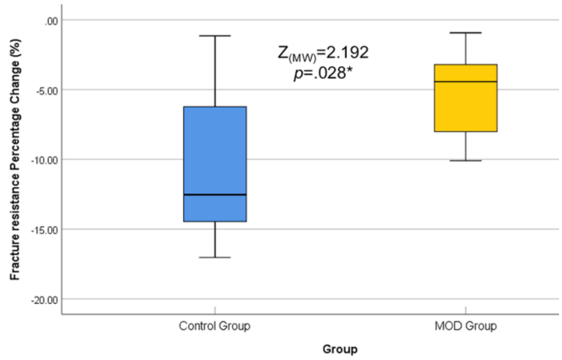

Figure (6): Box and whisker graph of Fracture Resistance percentage change (%) in the studied groups, the thick line in the middle of the box represents the median, the box represents the inter-quartile range (from 25th to 75th percentiles), the whiskers represent the minimum and maximum.

Table (1): Comparison of the Fracture Resistance (N) before and after fatigue in the studied groups

Fracture Resistance (N)	Group		Test of significance *p-value*
	Control (n=10)	MOD Group (n= 10)	
Before Fatigue			
Min. – Max.	987.24-1410.69	1011.65-1402.30	
Mean ± SD	1203.79±110.23	1267.05±116.28	$Z_{(MW)}$=1.436
Median	1200.53	1294.11	*p*=.151 NS
95% CI for median	1156.23-1245.32	1243.45-1342.50	
25^{th} –75^{th} Percentile	1156.23-1245.32	1243.45-1342.50	
After Fatigue			
Min. – Max.	870.23-1236.47	979.15-1389.25	
Mean ± SD	1076.86±128.27	1202.00±125.33	$Z_{(MW)}$=1.663
Median	1037.26	1200.41	*p*=.096 NS
95% CI for median	987.72-1198.78	1168.23-1295.47	
25^{th} –75^{th} Percentile	987.72-1198.78	1168.23-1295.47	
Test of significance	$Z_{(WSR)}$=2.803	$Z_{(WSR)}$=2.803	
p-value	*p*=.005*	*p*=.005*	
Percentage Change (%)			
Min. – Max.	-17.04 - -1.14	-10.10 - -0.93	$Z_{(MW)}$=2.192
Mean ± SD	-10.62±5.71	-5.18±3.11	*p*=.028*
Median	-12.53	-4.44	
95% CI for median	-14.46 - -6.23	-8.01 - -3.21	
25^{th} –75^{th} Percentile	-14.46 - -6.23	-8.01 - -3.21	

N=number of specimen
Min. – Max.: minimum – maximum
SD: standard deviation
CI: Confidence Interval
MW: Mann-Whitney U
df- degree of freedom
WSR : Wilcoxon Sign Rank

DISCUSSION

There is still a lack of thorough preclinical and clinical data regarding premolar restorations. VOnlay restorations are a popular option for posterior teeth with large cavities brought on by caries because of their exceptional aesthetic results and preservation of tooth structure.

In our study, there was no discernible difference in fracture resistance between the MOD and Control groups. Nonetheless, the MOD group's percentage decline in fracture resistance was statistically substantially higher than that in the Control group. (*p* = .028).

Guess et al.(31) demonstrated that pressable LDS ceramic Onlay restorations fracture resistance was unaffected by a reduction in preparation depth to one and half millimeters. On the other hand, it reduced failure loads for premolar complete veneer restorations. Additionally, when compared to standard thicknesses, palatal-Onlay restorations showed noticeably greater fracture resistance at ultra-thin thicknesses. (*p* = .015). Onlay restorations were unaffected by changes in thickness, although traditional complete veneers showed much higher fracture stresses than thin and ultra-thin restorations. The results of the current investigation (median: 1200.41 N [1168.23-1295.47 N]) are consistent with their reported median fracture load of 1300 N (1130–1532 N).

A mean fracture load of 1559 ± 337 N was reported by Chang, Yu, and Lin (32) for ceramic restorations that replaced the palatal cusp and had buccal cuspal coverage. This was significantly higher than the values found in Group III prior to fatigue in this investigation.

Hassan et al. (2020)(33) evaluated the fracture resistance of maxillary molars repaired with LDS Glass-ceramic occlusal veneers utilizing two distinct preparation designs and the Thermo Mechanical Load Cycling procedure. The marginal chamfer minimally invasive occlusal veneer preparation showed encouraging fracture resistance, on par with the conventional conservative preparation for

CAD/CAM LDS occlusal veneer restoration of molars.(33)

Different premolar preparation designs, including occlusal veneers and those that incorporate lingual and proximal surface coverage, were investigated by Zhang et al. (2020)(34). According to their research, these designs outperformed conventional full-coverage crown restorations in terms of fracture strength.(34)

VOnlays are the perfect minimally invasive and aesthetically pleasing treatment, according to Kim et al. (2017),(35)especially for patients with severe cavities, cervical decay, or occlusal problems in premolars and even molars. This is consistent with the current study's Group III buccal veneer with MOD restoration plan.(35)

VOnlay restorations combine the advantages of Onlays and laminate veneers with less tooth preparation, making them a better option than full-coverage restorations, according to Al-Akhali et al. (2019),(14). They complement the Group III buccal veneer with MOD restoration design in this study and are primarily utilized for posterior teeth that have cavities affecting both the biting and outer surfaces.(14)

The fracture resistance of pressable LDS ceramic Onlay restorations was shown to be unaffected by reducing the preparation depth to one and 0.5 mm by Guess et al. (2013),(36) demonstrated that decreasing the preparation depth to one mm and 0.5 mm had no adverse effect on the fracture resistance of pressable LDS ceramic Onlay restorations. On the other hand, it led to reduced failure loads for premolar full veneer restorations. Furthermore, at ultra-thin thicknesses as opposed to conventional thicknesses, palatal-Onlay restorations demonstrated noticeably greater fracture resistance. However, differences in thickness had no effect on the Onlay restorations' ability to withstand fractures. Standard full veneers had substantially higher fracture stresses than thin ($p = .03$) and ultra-thin restorations. This discovery aligns with our findings.(36)

Using modified USPHS criteria, Mohamed A. Hazzaa et al. (2023),(37) assessed fracture, marginal integrity, and marginal discolouration to compare the clinical performance of premolars repaired with ceramic VOnlays versus Onlays. For 26 crucial premolar teeth, pressable LDS ceramic partial coverage restorations were used in the study. When comparing the clinical performance of maxillary premolars restored with complete Onlay and VOnlay designs utilizing pressable LDS ceramic material over a one-year period, the study observed no statistically significant differences in fracture, marginal integrity, and marginal discolouration.

The average fracture resistance of occlusal veneers produced of zirconium oxide ceramic ranged from 1086 to 1640 N, whereas those manufactured of LDS ceramics showed values between 456 and 1044 N, according to Łukasz Czechowski et al. (2023),(38) According to these results, zirconium oxide ceramics are more resistant to fracture than LDS ceramics.(38)

Occlusal veneers composed of LDS and zirconia-reinforced lithium silicate shown higher fracture resistance than those produced of PMMA resin and polymer-infiltrated ceramic, according to Majed Al-Akhali et al. (2017)(39).

Moreover, the predominant (60.00%) failure mode was class II in the MOD Group. Schwendimann and Özcan(40) observed that root fractures had little to no clinical significance among various failure types. This could be due to pre-existing fissures in the extracted teeth or the cumulative effect of repetitive stress during the mastication simulation. It is important to evaluate these results in light of the failure mode analysis carried out in this investigation. 1,200,000 loading cycles were applied to the recovered teeth, proving that cyclic loading in conjunction with temperature fluctuations improves the clinical condition simulation.

In line with the goals of this study, future research should incorporate sophisticated fatigue components into the experimental design to get more clinically meaningful data on the material's final strength after fatigue. However, neither synthetic saliva nor human saliva nor acidic stimuli found in the mouth cavity were used as testing media in this investigation. The degree of dentin depth or dental tissue demineralization may have an impact on veneer adherence; this is a study limitation that warrants more investigation. It is advised to decrease the incisal section in preparation design in order to ensure uniform load distribution and lessen stress on the veneer material.(40)

CONCLUSIONS

The LDS-prepared premolars with a buccal preparation with 0.7 mm depth, buccal cusp reduction, and MOD box preparation showed the lowest fracture resistance after fatigue.

RECOMMENDATIONS

Non-retentive, minimally invasive LDS full-veneer restorations with buccal cusp reduction and buccal preparation depth, and MOD box preparation exhibited high failure loadsparticularly in adhesively cemented, reduced-thickness (0.7 mm) designs that were simultaneously thermocycling and cyclic mechanical loading. A viable treatment option for buccal MOD deficiencies, particularly in maxillary premolars, is offered by these restorations. Nevertheless, more clinical research is required to confirm these in vitro results.

LIMITATIONS

The results of this investigation are specific to the luting systems and all-ceramic materials that were assessed. Furthermore, the use of human teeth adds heterogeneity because of changes in hard tissue thickness, storage length, and morphology, all of which could impact how broadly applicable the findings are.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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