Effect of Overlay Material type and Design on Fracture Resistance of MOD cavities in molars.(In-Vitro Study)

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Abstract:

Objective: To evaluate the influence of restoration material type (CAD/CAM lithium disilicate blocks and reinforced composite blocks) and restoration design on fracture resistance of molars with MOD cavities.

Methods and Materials: A total of 54 sound human molars were divided into 2 groups (n=9) according to: 1) material type: lithium disilicate CAD/CAM blocks and reinforced composite CAD/CAM blocks; 2) restoration design: overlay with intra-coronal extension or without intra-coronal extension. Additional 18 samples were assigned to positive control group (sound molars, n=9) and negative control group (unrestored MOD cavities, n=9). Standardized MOD cavities were prepared with occlusal width 3 mm, cavity depth 4 mm and cavity walls with occlusal divergence of 8-10 degrees. Gingival steps were prepared proximally with depth and width of 2 mm. Occlusal reduction was 2 mm for functional cusps and 1.5 mm for non-functional cusps. Occlusal margins A were prepared in concave chamfer finish line. Cavities receiving overlays without intra-coronal extension were filled with nanohybrid resin composite core. Restorations were manufactured using CEREC. All specimens were subjected to thermocycling (5000 cycles). Fracture resistance test was done using universal testing machine. The load to fracture was recorded in Newton. Data were statistically analyzed by ANOVA and Student-t test.

Results: Study variables and their interactions showed no significant effect on fracture resistance. There was no significant difference in maximum load mean values between all study groups.

Conclusion: CAD/CAM fabricated overlays (either lithium disilicate or composite) can restore fracture resistance of human molar teeth with MOD cavities. CAD CAM composite blocks are considered as

promising materials and an alternative to lithium disilicate CAD CAM blocks in restoring MOD cavities with or without intra-coronal extension design.

Keywords: CAD/CAM, Composite block, Ceramic, Overlay, Indirect restoration

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Introduction:

Challenges in making decisions for restoring teeth in the posterior region are often encountered in daily practice, depending on clinical scenario and degree of destruction. Indirect partial restorations such as inlays, onlays and overlays are usually the preference of dental clinicians in large cavities; as they are proven to be minimally invasive than full coverage crowns as tooth removal is reduced by 40%[1].

Recent advances in adhesive restorative materials along with progresses in CAD/CAM technologies have increased the longevity and performance of indirect restorations[2]. The introduction of predictable adhesive technologies has led to an exceptional interest in “minimally invasive dentistry”,[3] a concept by which it is now possible to develop better treatment options that meet the biological, biomechanical and esthetics objectives of dentistry.

In attempts to enhance the mechanical properties of restorations, industrially made CAD/CAM blocks have been introduced to dentistry. Manufacturing ceramics under industrial conditions resulted in remarkable reduction in voids, flaws and cracks in comparison with conventional laboratory techniques[4]. Glass ceramics, such as lithium disilicate, offer adequate fracture resistance, high esthetics, biocompatibility to soft tissues, good survival rates, high elasticity modulus, and better wear resistance[5]. In 2021, Dentsply Sirona introduced a new advanced lithium disilicate CAD/CAM block (Tessera, Dentsply Sirona). A new composition of the ceramic composed of disilicate of lithium and virgilite; a lithium aluminum silicate. This ceramic is characterized mainly by the fact that it can be fired quickly. The glaze firing takes only four and a half minutes. It is indicated in the anterior and posterior region for crown, inlay, onlay, and veneer[6].

The performance of CAD/CAM composite resin restorations is favorable through a superior bond to underlying structure resulting in appropriate stress transfer, low abrasiveness of opposing teeth, low elastic modulus that allows absorption of functional stresses. The development of the nano-scaled fillers offers an advantage of great esthetics, excellent polishability and high strength[4]. However, these polymer-based materials possess their own limitations, e.g., wear, discoloration, and low fracture strength[7]. Brilliant Crios blocks (Coltėne) have been recently introduced to the market. They have many advantages such as they do not require firing, easily repaired, easily milled, and have high fatigue resistance [8].

Variations in mechanical properties of ceramic and resin-based materials raise the question regarding which material is capable of surviving in the load-bearing posterior region[7]. The fracture resistance of indirect partial restorations might be influenced by the properties of the underlying supporting structures and the preparation design[4]. A biosubstuition in which a combination of materials is used to exhibit a physicomechanical properties close to the natural tooth, which is the first step towards bioemulation (i.e composite resin as a dent in substitute and ceramic as enamel substitute)[9].

Based on the previous considerations, it would be of value to evaluate the influence of material type and presence of a resinous core on the fracture resistance of CAD/CAM partial coverage restorations. The null hypothesis was that neither the material type nor the restoration design influenced the fracture resistance of partial coverage restorations.

Objectives:

The aim of this in-vitro study was to evaluate the influence of restoration material type (either CAD/CAM reinforced composite blocks or CAD/CAM lithium disilicate blocks) and the restoration design on fracture resistance of human molars with MOD cavities.

Materials and Methods:

Materials:

All materials' description, composition, lot number and manufacturer are represented in table (1).

Table 1: Materials' description, compositions, Lot numbers and manufacturer.

Material	Description	Composition	Lot Number	Manufacturer
Tessera Blocks	Monolithic lithium disilicate CAD/CAM blocks. Shade A3.5	Lithium disilicate ($Li_2Si_2O_5$), virgilite ($Li_{0.5}Al_{0.5}Si_{2.5}O_6$), zirconia enriched glass matrix.	16011269	Dentsply Sirona
Brilliant Blocks	Reinforced nanohybrid composite CAD/CAM blocks	Barium glass (size 1 pm), amorphous silica $Si0_2$ (size « 20 nm), cross-linked methacrylates, inorganic pigments as ferrous oxide or titanium dioxide.	K56598	Coltène/Whaledent; Coltène, Alstatten, Switzerland
Spectra ST HV	Nanohybrid resin composite	Filler load 78-80% weight of blend of spherical, pre-polymerized fillers (15 µm),	220300008	Dentsply Sirona, USA

		non-agglomerated barium glass and ytterbium fluoride, methacrylic polysiloxane nano-particles.		
Spectra ST flow	Highly filled flowable composite	-Resin matrix: urethane modified BisGMA, BisEMA, diluents, camphorquinone, stabilizers, pigments. -Fillers (0.1-3 μm, 62.5% weight): barium-aluminum-borosilicate glass, ytterbium fluoride, iron oxide pigments, titanium oxide pigments, catalysts, additives, stabilizers, pigments.	2202000888	Dentsply Sirona, USA
Prime&Bond Universal	Universal light-cured adhesive	Bi- and multifunctional acrylate, phosphoric acid modified acrylate resin, initiator, stabilizer, isopropanol, water.	2204000699	Dentsply Sirona, USA
Calibra Universal	Dual-cured self-adhesive resin cement	Phosphoric acid modified monomer PENTA, mono- and di-functional hydrophilic methacrylates.	6L200100	Dentsply Sirona, USA
Etching Gel	37% Phosphoric acid etch	37% H_3PO_4 semi-gel.	P0803137	President Dental, Germany
Bisco Porcelain Etchant	9.5% Buffered Hydrofluoric acid etch	Hydrofluoric acid, 7%<=conc<=60%, aqueous solutions, sodium fluoride.	2300001105	Bisco, France
Bisco Porcelain primer	Pre-Hydrolyzed silane primer	Single component silane coupling agent in an alcohol and acetone base.	2200006433	Bisco, France
Aluminium Oxide	Abrasive powder	Oxide aluminium particle (53 um size).	100119	Velopex International,

				UK

Methods:

-Sample size calculation:

Sample size calculation was achieved using G*Power 3.1.9.4 software. Based on a previous study by Van Lierop et al. (2017)[3] the difference in maximum load values between at least 2 groups is 937±372.2 N. Using power 80% and 5% significance level, we will need to study 7 samples per each group. The sample size was increased by 30% to 9 samples per group for a total of 54 samples to compensate for pre-test failures.

-Teeth collection:

Fifty-four freshly extracted sound molars were collected at The British University of Egypt (BUE), Faculty of Dentistry and Department of Oral Surgery after taking the approval of patients who had extraction procedures. Teeth were examined under magnification to verify absence of caries, cracks or fractures. Teeth were cleaned of gross debris and soft tissues with a periodontal scaler, disinfected in 0.4% thymol for 24 hours, and then stored in distilled water at room temperature to be used within 3 months.

-Samples grouping:

Selected teeth were randomly divided into two main groups (n=9) according to study variables: 1) material type (lithium disilicate CAD/CAM blocks and reinforced composite CAD/CAM blocks); 2) restoration design (overlay with intra-coronal extension or without intra-coronal extension). Additional 18 samples were divided into two control groups (9 each); positive control as sound teeth with no cavity preparation and negative control as teeth with unrestored MOD cavities.

-Teeth mounting and periodontal ligament simulation:

The root of each specimen was marked by waterproof marker at 2 mm below cemento-enamel junction. To simulate periodontium, root surfaces were covered by wax using dental lab electric wax machine to a depth of 2 mm below cemento-enamel junction to form a uniform coat of about 0.5 mm around root[10]. Afterwards, the roots were mounted in self-cure acrylic resin blocks (Acrostone, Egypt) with dimensions of (2.5cm×2.5cm) using a specially designed centralization guide device, to ensure that teeth were mounted with their long axis perpendicular to the base of the block. All roots were embedded except for 2 mm apical to cemento-enamel junction to approximate the support of alveolar bone in a healthy tooth [10]. After setting of acryl, teeth were removed from acrylic block, wax spacer was removed, light body poly-vinyl siloxane material (ExpressTM VPS Impression Material, 3M, USA) was injected in space between mold and root, then teeth were re-inserted in the mold and excess impression material was removed with a surgical blade. A standardized silicone layer that simulated periodontal ligament was thus created taking thickness of wax. This method seemed to simulate the periodontal ligament [11].

-Cavity preparation:

Before cavity preparation, occlusal custom-made index was made using putty rubber base material (ExpressTM VPS Impression Material, 3M, USA) to be used as a reference to check occlusal clearance. Cavities were prepared using a round-end parallel diamond bur (881.31.014 FG; Brasseler USA Dental, Savannah, GA) in a high-speed handpiece (PANA MAX, NSK, Japan) under copious amount of water. Diamond burs were discarded after every 4 preparations. After preparation, cavity dimensions were rechecked by periodontal probe (Hu-Friedy Co., Rockwell St. Chicago). MOD cavities were prepared with occlusal width of 3 mm, depth of 4 mm and occlusal divergence of 8-10 degrees. All internal line and point angles were rounded. Gingival steps were prepared mesially and distally with depth, width and axial depth of 2 mm. For occlusal reduction, depth cuts were made at cusps inclines using 330 carbide bur (Komet, USA) in a longitudinal direction, followed by using abrasive cylindrical blue coded stone (MIDWEST Dentsply) following inclination of cusps to connect depth cuts and obtain occlusal reduction in an anatomical form. Occlusal reduction was 2 mm for functional cusps and 1.5 mm for non-functional cusps. A concave chamfer finish line was prepared all around cavity margins using abrasive cylindrical blue coded stone. All cavity walls were finished using tapered round end yellow-coded finishing stone (#368EF, Komet, USA).

-Bonding procedures and cavity optimization:

After cavity preparation, immediate dentin sealing was performed for all specimens. A universal adhesive system (Prime & Bond universal, Dentsply Sirona, USA) was applied in the self-etch mode on dentin by rubbing the saturated micro-brush (microbrush, USA) over dentin surface for 20 seconds, followed by gentle air thinning for 10 seconds, then light cured for 20 seconds using a LED curing light (Elipar™ Deep Cure-L, 3M ESPE, Germany). A highly filled flowable composite (Spectra ST flow, Dentsply Sirona, USA) was applied in about 1 mm thickness, left for 10 seconds to allow its flow and then light cured for 20 seconds. All enamel margins were subsequently finished to remove any resin remnants using a yellow-coded finishing stone. For specimens of overlays without intra-coronal extension, a pre-contoured circumferential molar matrix (Metafix, Kerr, Germany) was applied and tightened, then the prepared cavity was filled with a nanohybrid resin composite core (Spectra ST HV, Dentsply Sirona), applied in 2 inclined increments (1 mm each). Each increment was light cured for 20 seconds. After every 5 restorations, light intensity output was checked with a radiometer (3M ESPE, USA) Excess composite was removed and finished using a yellow coded finishing stone.

-Overlay restorations fabrication:

a. Digital dental impression:

Each specimen was scanned using Omnicam intraoral camera of CEREC system software version 4.60 (Sirona Dental systems GmbH**,** D- 64625 Benshein, Germany) for taking the optical impression. Optical impression was checked to avoid incomplete image that would affect final design.

b. Designing overlay restorations on software:

The margin was drawn, and the final design was acquired and checked for any corrections. A new restoration was created in Cerec software version 4.60. The 3-D virtual model displayed on design window was then used to design the restoration with the help of the software given tools. Parameters for machining of restorations were adjusted according to restoration type (lithium disilicate or composite). Virtual die spacer of 50 µm was used. In order to ensure a standardized occlusal surface thickness; occlusal surface of all restorations was adjusted to 1 mm deep at the central fossa or transverse groove, 1.5 mm at non-functional cusp, and 2 mm at functional cusp. Finally, virtual restorations were fabricated according to cusp anatomy selected shape by using software tools in design windows box. The cut tool was used, which can take a segmental cut through any plane of 3D model die. Marginal adaptation was checked in all designs.

c. Milling process:

MCXL milling machine (Dentsply Sirona, USA) was activated and restorations were milled from used materials (lithium disilicate or composite) with block size 14. For standardization, milling process was repeated for all blocks with the exact same milling parameters. After milling procedure, all restorations were checked by caliper to confirm restoration thickness. Lithium disilicate (Tessera) restorations were crystallized in a ceramic furnace (CEREC SpeedFire, Dentsply Sirona, Milford, USA) for 30 minutes at a final temperature of 8508˚C under vacuum. After removal of sprue and polishing with rubber tips, restorations were glazed at 7708˚C. Composite restorations were polished with a silicone tip (Enhance kit, Dentsply Sirona) operated at low speed contra-angle handpiece (NAC-EC, NSK, Japan) with a maximum speed 20,000 rpm under water coolant and minimal pressure, and a diamond paste (MASTER DENT).

-Restoration try-in and cementation procedures:

Restorations were assessed for adequate fit in try-in and was cleaned with 99% isopropanol in an ultrasonic cleaner for 5 minutes.

For lithium disilicate overlays, fitting surfaces were etched with 9.5% hydrofluoric acid (Bisco Porcelain Etchant, Bisco, France) for 20 seconds, rinsed with water stream for 60 seconds and gently air-dried with oil-free compressed air. Then fitting surfaces were etched with 37% phosphoric acid (Etching gel, President Dental, Germany) for 60 seconds for cleaning, rinsed with water stream for 60 seconds and gently air-dried. Subsequently, treated surfaces were silanated by one-component silane coupling agent (Porcelain Primer, Bisco, France). Silane was left to react for 60 seconds, then air dried. Universal adhesive (Prime&Bond, Dentsply) was rubbed on fitting surfaces for 20 seconds, air thinned for 20 seconds, and light cured for 20 seconds.

For composite overlays, intaglio surfaces were sandblasted with Aqua Care (Aquacare twin air abrasion and polishing unit, Velopex, UK) with 50 μm aluminum oxide particles at 2 bar pressure at 90 degrees, at 10 mm distance for 20 seconds; followed by air rinsing with water stream for 60 seconds and gentle air-drying with oil-free compressed air. Ultrasonification of restorations by ultrasonic cleaner for 2 minutes was done followed by air-drying. Universal adhesive (Prime&Bond, Dentsply) was rubbed on fitting surfaces for 20 seconds, air thinned for 20 seconds, and light cured for 20 seconds.

Air abrasion of immediate dentin sealing surface or resinous core was done with AquaCare twin air abrasion and polishing unit with 50 μm aluminum oxide particles at 2 bar pressure at 90 degrees, at 10 mm distance for 20 seconds. Etching of IDS and resinous core for 60 seconds to clean any surface contaminants and enamel margins for 30 seconds. Etched surfaces were rinsed with water stream for 60 seconds and gently air-dried. Universal adhesive (Prime & Bond, Dentsply) was rubbed for 20 seconds, air thinned for 20 second and light cured for 20 seconds.

A dual-cure resin cement (Calibra Universal, Dentsply Sirona, USA) was injected inside the cavity and restorations were seated over preparation using finger pressure. The cement was initially cured for 5 seconds at 2 mm distance. Following initial light curing, excess luting material was removed using a probe while maintaining finger pressure. Then final light curing from each aspect for 20 seconds while maintaining finger pressure. Any excess cement at the margins was scrapped using sharp lancet and polished using polishing tips and paste (Enhance kit, Densply Sirona).

-Thermocycling:

All specimens were thermo-cycled for a total number of 5000 cycles which approximately represents 6 months of clinical service before fracture resistance test. Specimens were alternated between 5 and 55 ◦C ± 2 with a dwell time of 5 seconds and 5 seconds transfer time between each bath according to ISO 11405 recommendations. Afterwards, all specimens were carefully evaluated under an optical microscope to check for cracks or debonding.

-Fracture resistance test:

All specimens were tested for fracture resistance within 24 hours after thermo-cycling. All specimens were subjected to compressive axial loading until fracture in a computer-controlled universal testing machine (LRX-plus, LLOYD instruments Ltd., Fareham, UK) with crosshead speed 1mm / min. Each tooth with its acrylic block was fixed to the base of testing machine whose position was adjusted in such a position that loading piston was centered along long axis of specimen. Loading piston was a spherical vertically movable rod of 4 mm diameter. It was applied on inclined planes of both buccal and palatal cusps of restorations and halfway the distance between cusp tip and central groove. Load was increased until first fracture occurred. The outcome is maximum load at which the tooth was fractured. All samples were loaded until fracture and maximum breaking loads were recorded in Newton (N).

-Statistical analysis:

Statistical analysis was performed with R statistical analysis software version 4.3.1 for Windows. Numerical data were presented as mean and standard deviation (SD) values. Data were tested for normality using Shapiro-Wilk's test. The effect of study variables and their interaction were analyzed using two-way ANOVA. Intergroup comparisons between study groups were done using One-Way ANOVA. The significance level was set at $p<0.05$.

Results:

1- <u>Effect of study variables and their interaction:</u>

Study variables and their interactions showed no significant effect on fracture resistance table (2).

Table 1: Effect of study variables and their interactions on fracture resistance (N).

Variable	Sum of Squares	df	Mean Square	f-value	p-value
Material type	873467.15	1	873467.15	3.89	**0.063ns**
Cavity design	392898.62	1	392898.62	1.75	**0.201ns**
Material type * Cavity design	339254.99	1	339254.99	1.51	**0.233ns**

df =degree of freedom*; ns: non-significant ($p>0.05$)

2- <u>Intergroup comparisons:</u>

There was no significant difference between different groups ($p=0.111$). The highest value was found in positive control group (2000.78±787.33), followed by composite overlay without intra-coronal extension (1947.83±512.63), then composite overlay with intra-coronal extension (1929.72±406.03), lLithium disilicate overlay without intra-coronal extension (1804.07±529.65) and negative control (1361.10±29.33), while the lowest value was found in lithium disilicate overlay with intra-coronal extension (1310.39±435.64).

Table 2: Intergroup comparisons, mean and standard deviation (SD) values of fracture resistance (N).

Fracture resistance (N) (mean±SD)						p-value
Lithium disilicate overlay with intra-coronal extension	Composite overlay with intra-coronal extension	Lithium disilicate overlay without intra-coronal extension	Composite overlay without intra-coronal extension	Negative control	Positive control	
1310.39±435.64	1929.72±406.03	1804.07±529.65	1947.83±512.63	1361.10±29.33	2000.78±787.33	**0.111ns**

ns; non-significant (p>0.05)

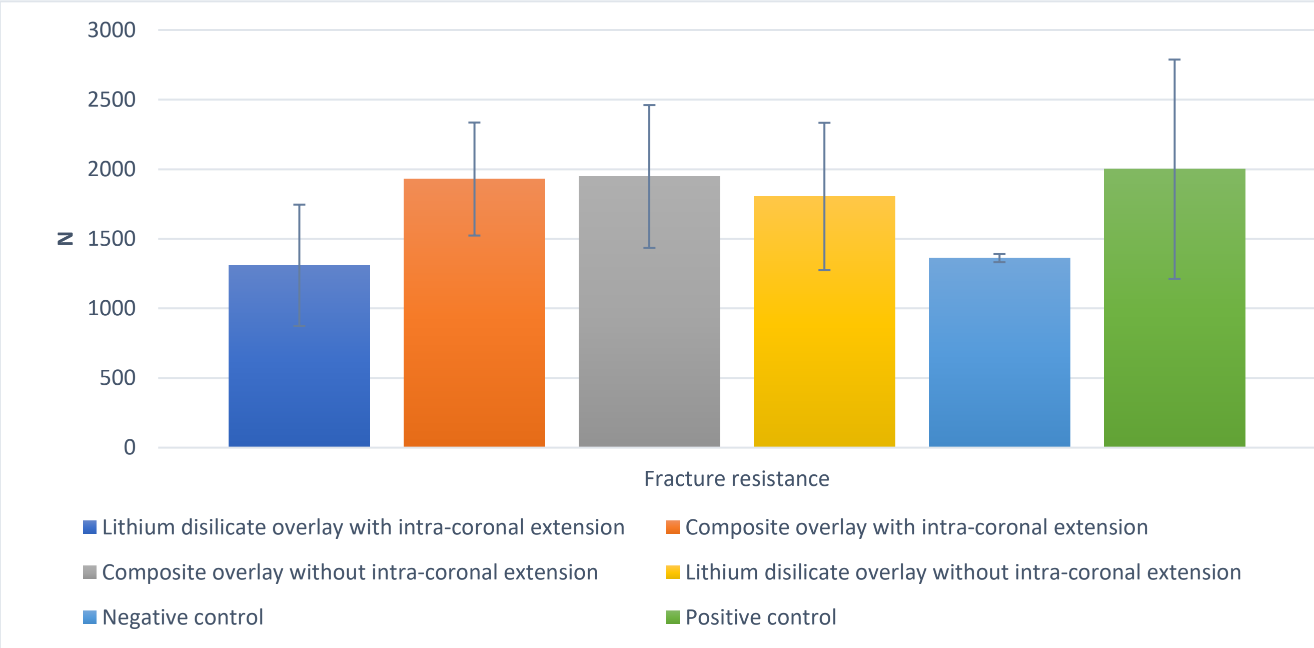

Figure 1: Bar chart showing maximum load mean values (N) for different groups.

Discussion:

Indirect partial coverage restorations are routinely used to restore teeth that have been damaged. They can be constructed using ceramic or composite resin materials. It has been recommended to use composite resin restorations or adhesive ceramic inlays for internal tooth strengthening rather than full occlusal coverings.[12],38Ceramic blocks are known for their high mechanical, optical, chemical, and biocompatibility stability. Their rigidity and brittleness, however, may be considered as disadvantages. Resin composite materials have progressed remarkably quickly over the past ten years. Nanohybrid resin composite restorations are well known for their ability to compete with ceramic indirect restorations for function and aesthetics in many clinical settings due to their outstanding mechanical and physical properties.[14]

Recently, CAD/CAM-produced composite resin blocks were introduced. Since CAD/CAM blocks are pre-polymerized into blocks that are ready for milling, they have an advantage over standard resin composite materials in that curing stage is eliminated. This controlled and optimized curing may make resin composite blocks superior to conventional resin composite material because of increased homogeneity, absence of operator-related variables, and unmatched mechanical properties provided by the high filler content (80% by weight) with excellent physical values for flexural strength and abrasion.[15]

The design of cavity preparation is essential for maintaining tooth's maximum biomechanical considerations and enabling optimal protection. Size of cavity and how much of a healthy dental structure still present influence direction and analysis of forces applied on the tooth, which in turn influences distribution of stress and fracture resistance. In the present study, a precise preparation with diverging walls and no undercuts was carried out. In groups of intra-coronal extension of both CAD/CAM materials, an appropriate cavity design optimization was carried out using a flowable composite material. In groups without intra-coronal extension, cavity design optimization was carried out with a resinous core by complete filling of nanohybrid composite to the entire cavity to simulate clinical scenarios in which existing direct restorations are required to be changes into indirect ones for repair or occlusion adjustment purposes, with the aim to prevent additional removal of healthy tooth structure and follow monoblock concept as possible.

Cusps thickness needed to be at least 2 mm for all groups in order to allow for cusp preservation. For optimum tooth preservation and better stress distribution over cusps and axial walls, cusp reduction was carried out in anatomic form. Cavity optimization by using resin composite liners or a base material with a low modulus of elasticity, which has become more popular in recent years.[16] Flowable composites have often been shown to have positive effects when utilized as a stress-breaker intermediate layer. Low elastic modulus significantly improved biomechanical behavior of reconstructed tooth and consequently increased fracture resistance since it reduced stresses on the dentin.[17]

In our research, we attempted to mimic clinical setting, immediate dentin sealing was performed for restorations with intra-coronal extension. Since only a single type of adhesive was used throughout the entire study's adhesive procedures, a self-etch strategy of "universal adhesive" system was employed to avoid adhesive strategy variations. Due to the fact that they do not eliminate smear layer in hybridization area but rather include it, self-etch adhesive methods are widely believed to reduce the likelihood of post-operative sensitivity in more recent research. Dentin tubules are also more likely to stay sealed because dentin conditioning and resin infiltration happen simultaneously.[18–20] According to research by Duarte et al. in 2009, immediate dentin sealing produced high bond strengths for both total-etch and self-etch dentin bonding agents.[21]

Dimensional accuracy of intraoral scanner used for CAD CAM indirect restorations is essential and necessary for precise replication of tooth preparation measurements and their arch position. Creation of digital models offers various benefits, including a decreased need for storage, quick access to 3D diagnostic data, and simple digital data transfer for professional and patients for communication. Additionally, digital dental models enable development of custom made fixed prothesis through improving treatment plan by virtual setups.[22,23]

Regarding thermocycling of specimens, it was done to replicate the clinical scenario by simulating ageing of restorations. Thermocycling has been recognized as an effective in vitro technique to assess effects of temperature variations during mastication on dental materials in a short time. Maximum loads that cause fracture of specimens in the current study have been determined by compressing specimens until breakage. Compressive force was applied by a steel ball with a diameter of 4 mm on cuspal inclines of occlusal restorations beyond tooth-restoration interface, to replicate physiological function and provide significant non-axial loading through existing occlusal contact variations, the load direction was important to be chosen.[24]

Regarding effect of restoration materials, composite overlays with and without intra-coronal extension had higher, yet insignificant, numerical values, than those of lithium disilicate oerlays with and without intra-coronal extension. This could be attributed to high resiliency of composite material when compared to ceramic that led to better stress distribution.[25] Moreover, bonding of CAD/CAM composite blocks to underlying resinous materials as well as to tooth structures using resin cement might be better than that of ceramic CAD/CAM blocks with maximum achievement of monoblock concept [26]. Another explanation might be due to nature of materials used. Chipping factor (CF) of final restorations and brittleness of dental materials are correlated. It was discovered that lithium disilicate glass ceramic CAD/CAM blocks had the highest CF, whereas composite CAD/CAM blocks had the lowest CF. So chipping factor (CF) and brittleness index (BI) have a direct association with one another. Furthermore, a material that chips more during milling is likely to have an inferior level of marginal adaptation due to increased damage to margins [23] that might affect integrity of resin cement underneath ceramic restorations due to its degradation, especially after thermocycling. Consequently, this could be considered as discontinuity between restoration and underlying substrate that affect stress resolution adversely resulting in fracture of the restoration. In addition, the complex geometry of cavity design due to presence of intra-coronal extension might lead to unequal escapement of cement during placement of restoration leading to uneven thickness of cement as well as formation of voids in cement at restoration-cement interface especially along internal cavity walls. These voids act as a stress raisers decreasing bonding between cavity and indirect restoration.

Our findings were in agreement with Magne et al. in 2010[27], in which posterior occlusal veneers made of composite resin had significantly higher fatigue resistance compared to lithium disilicate groups. In addition, Albelasy et al in 2020[28] in a systematic review found that there was a significant relationship between choice of materials and fracture strength where polymeric materials performed better in fatigue testing in comparison to ceramics.

On the other hand, results of overlays without intra-coronal extension groups were in disagreement with those of Mostafa et al in 2023[29], who reported that lithium disilicate occlusal veneers had a significantly higher fracture resistance value than composite in 0.5 mm and 1 mm thicknesses. This could be attributed to using premolars rather than molars, also using different composite block type than the one used in the current study. In addition, results of our study were not in line with El Khali et al in 2017[30] who found that fracture resistance of lithium disilicate occlusal veneers was higher than polymer infiltrated ceramics. This can also be attributed to the difference in investigated variables as teeth type, preparation thickness, bonding substrate (enamel), and CAD/CAM blocks.

Concerning cavity design, in both materials used; overlays without intra-coronal extension had a higher value than those with intra-coronal extension yet the difference was not statistically significant. This might be explained by cavity design optimization that plays an important role in reinforcement of cavity walls, minimizing pulp irritation and improve bond strength between a resin cement and tooth structures[31,32]. Moreover, a biosubtituition[33] is achieved through using a mix of materials that have physico-mechanical qualities similar to those of natural dentin and enamel (i.e., composite resins as dentin substitutes and ceramics as enamel substitutes). This is an attempt to increase longevity of the underlying tooth structure. Biomimetics aims to reproduce and bio-mimetically match the restorative materials with the natural tooth substrates; this is achieved through understanding the composition of the natural tooth and finding ways to mimic it. In addition, a severely damaged tooth can benefit from additional support by using resin composite as the resinous core beneath indirect restorations. [33] Thus, making occlusal restorations not as thick as they used to be and simplification of cavity design is achieved. In addition, a compression dome concept is attained through the anatomical reduction of the occlusal surface thus converting all the occlusal stresses into a compressive force rather than a lateral one which is more favorable for the tooth-restoration complex.[34]

These results were in agreement with Gurpinar and Celakil in 2020[35] who reported no statistically significant differences were found in terms of fracture strength between occlusal veneer (without intra-coronal extension) and overlay groups (with intra-coronal extension). In addition, Channarong et al. in 2022[36] whose results showed no statistical difference in fracture resistance between different overlay designs with combination of different axial wall heights (1 mm, 2 mm, and 3 mm) in MOD cavities with 2 mm occlusal reduction.

On the other hand, these results were in disagreement with Tavarez et al. in 2021[37]where a significant difference between ceramic fragment group and ceramic overlay group was found. They concluded that teeth restored with ceramic fragments may offer greater resistance to fracture compared to teeth that have overlay restorations. This can be attributed to larger sample size and using different tooth type as they used premolars.

Finally, it should be mentioned that many limitations were faced in this study as the used materials' cost and testing steps. Also, longer storage period as well as dynamic loading are advised to evaluate the tested outcome. Therefore,the null hypothesis of this study was rejected regarding the effect of materials used and accepted concerning the restoration design.

Conclusions:

Under the limitations of the current study, the following conclusions could be derived:

1. CAD CAM composite blocks are considered as promising materials and an alternative to lithium disilicate CAD CAM blocks in restoring MOD cavities with or without intra-coronal extension design.
2. Occlusal overlay fabricated of lithium disilicate and composite CAD/CAM blocks with resinous core is considered a very efficient protocol to restore human molar teeth with MOD cavities.

Recommendations:

1. Randomized controlled clinical trials (RCTs) should be carried out to confirm our findings.
2. Further long-term evaluation must be done to confirm the fracture resistance findings.
3. Using different adhesive techniques, cements and CAD-CAM blocks, to reach a standardized methodology for restore human molar teeth with MOD cavities.

Conflict of interest:

Authors have no conflict of interest to declare.

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