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Influence of different composite materials and cavity preparation designs on the fracture resistance of mesio-occluso-distal inlay restoration

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The aim of the study to evaluate the fracture resistance of a computer-aided design/computer-aided manufacturing (CAD/CAM) and three indirect composite materials for three different mesio-occluso-distal (MOD) inlay cavity designs. A total of 120 mandibular third molar were divided into three groups: (G1) non-proximal box, (G2) 2-mm proximal box, and (G3) 4-mm proximal box. Each cavity design received four composite materials: Estenia, Epricord (Kuraray, Japan), Tescera (Bisco, USA), and Cerasmart CAD/CAM blocks (GC, USA). The specimens were subjected to a compressive load at a crosshead speed of 1 mm/min. The data was analyzed using the two-way analysis of variance and Bonferroni *post hoc* test ($p<0.05$). Estenia exhibited significantly higher fracture strength than Epricord and Cerasmart in G1. In G2 and G3, there was no significant difference among the four materials. Using a non-proximal box design for the cavity can improve the fracture resistance of the inlay restoration.

Keywords: Estenia, Tescera, Cerasmart, MOD cavity design, CAD/CAM

INTRODUCTION

The use of tooth-colored materials has become more popular due to an increased interest in tooth appearance[1)]. With a rising demand of patients looking for esthetic restorations, an interest in ceramic and composite materials has become evident. Composite resin has been the material of choice because of having an elastic modulus similar to dental structures, and a high potential to bond with enamel and dentin[2)]. When restoring the dental cavities with adhesives, two strategies are available: the direct technique, in which the restoration is polymerized in the mouth, and the indirect technique, where restoration fabrication occurs outside the mouth[3)]. Both alternatives have technical advantages and disadvantages.

Recently, it was also reported with a clinically study that conducted on excessive substance loss in posterior teeth, indirect restorations may be more preferable to direct restorations[4)]. Indirect resins provide precise marginal integrity, ideal proximal contacts, wear resistance, reduced polymerization shrinkage, and optimal aesthetics[5)]. However, they have two major limitations, in terms of being expensive and involving time-consuming fabrication stages[6)]. Indirect composite materials are characterized by a filler content possibly exceeding 70% by volume, which provides improved fracture strength because they can be significantly reinforced by postcure treatment[7)]. The postcure treatment allows for secondary curing of the composite by enhancing the conversion of the material from monomer to polymer[8)]. These composites are usually urethane tetramethacrylate(UTMA)-based resin systems. The monomer system selected was based on urethane dimethacrylate, because it has been shown that the presence of urethanes could improve mechanical/physical properties of the materials[9-11)].

Currently available indirect composites, Estenia, Epricord, and Tescera, are second-generation laboratory composite systems. Estenia is a tooth-colored indirect resin composite with the advantages of both ceramic materials and resin composites. This hybrid ceramic contains a high percentage of inorganic filler particles (92 wt%). A special filler surface treatment technique provides Estenia a highly homogeneous structure with excellent physical properties. Another indirect resin composite material, Epricord, is composed of UTMA, triethyleneglycol dimethacrylate (TEGDMA), and 85.4 wt% filler. The resin Epricord is cured only by light, in a light curing unit, which is different from other indirect resins. Tescera ATL system consists of a microhybrid composite and is polymerized in an oxygen-free environment. In addition to heat and light, the system utilizes air pressure for polymerization.

Composite resin inlays can also be fabricated using computer-aided design/computer-aided manufacturing (CAD/CAM) technology. These technologies were introduced in dentistry during the 1980s. During the last decade, CAD/CAM systems in dentistry have rapidly gained importance and popularity. Two main types of materials are currently available for esthetic CAD/CAM-processed indirect dental restorations: glass-ceramics/ceramics and resin-composites[12)]. Cerasmart is the latest CAD/CAM composite block that comprises a high-strength ceramic and a composite. This system exhibits superior physical properties due to the fully

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homogeneous and evenly distributed nano-ceramic network.

The success and the longevity of teeth restorations depend on not only the restorative material but also preservation of tooth structure[13]. The teeth with mesio-occluso-distal (MOD) cavity are subjected to a significant loss of tooth structure as a result of caries or aging restorations[13,14] and are considered more susceptible to fracture than intact teeth. Cavity preparations with or without a proximal box have been used for MOD cavities. However, till today, only limited data are available regarding the selection of the appropriate tooth-colored restorative material and their influence on the fracture resistance of the restoration for different cavity types. Thus, the aim of the present study was to evaluate and compare the effect of different indirect composite materials and cavity preparation designs on the fracture resistance of MOD inlay restorations. The null hypotheses tested were: 1) cavity type non-proximal box or proximal box extended gingivally with different depths does not affect the fracture resistance of the tooth-restoration complex and 2) the type of restoration material does not affect the fracture resistance of the tooth-restoration complex.

MATERIALS AND METHODS

Specimen selection and preparation

In this *in vitro* study, 160 freshly extracted, sound, caries-free human mandibular third molars with similar dimensions (mesio-distal: 9.5±0.5 mm, bucco-lingual: 12±0.5 mm) were collected and used within 1 month. The teeth had been extracted following appropriate consent procedures, and were from hospital dental department collections (2015/02). The teeth were cleaned using a rubber cup and fine pumice water slurry and examined to detect any preexisting defects. The teeth were disinfected in 0.5% chloramine solution and stored in distilled water until use and used within 1 month. The tooth specimens' roots were covered with a 0.3-mm layer of a polyether impression material (Impregum™ Soft, 3M ESPE, St. Paul, MN, USA) to simulate the periodontal ligament and embedded in a self-cure acrylic resin (Denture Base material, Self-cure (type II), Jiading, Shanghai, China) up to 2 mm below the cement-enamel junction to simulate the alveolar bone.

Ten intact teeth (having no cavity) were accepted as a positive control group. Three different mesial-occlusal-distal (MOD) inlay cavity designs were prepared on the remaining 150 teeth (n=50). The cavity designs

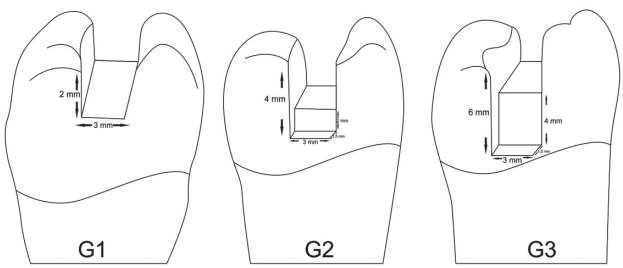


Fig. 1 Cavity design with dimensions: (G1) non-proximal box, (G2) 2 mm proximal box extended gingivally, (G3) 4 mm proximal box extended gingivally.

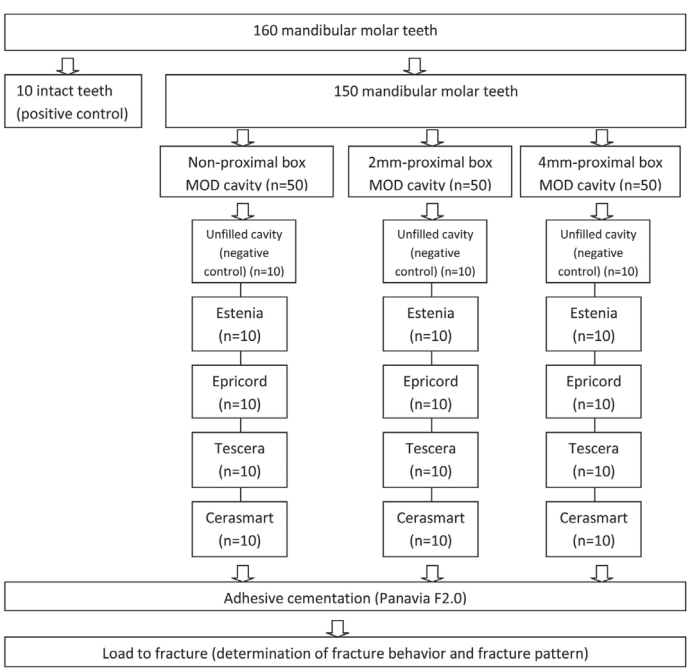


Fig. 2 Overview of the study design.

Table 1 Materials used in this study

Material	Type	Batch	Component	Filler	Filler content (wt%)
Estenia (Kuraray Medical, Tokyo, Japan)	Hybrid-ceramic	CQ0006	UTMA, methacrylate, *dl*-camphorquinone	Surface treated alumina micro filler, silanated glass ceramic filler	92
Epricord (Kuraray Medical)	Hybrid	0143BA	UTMA, TEGDMA, *dl*-camphorquinone, pigment	Organic filler, glass, silica, silanated colloidal silica	85.4
Tescera (Bisco, Schaumburg, IL, USA)	Micro-hybrid	1400001252	Ethoxylated bis-GMA, UDMA	Glass, amorphous silica	81
Cerasmart CAD/CAM composite blocks (GC America, Alsip, IL, USA)	Nano-ceramic	1412041	Bis-MEPP, UDMA, DMA	Silica (20 nm), barium glass (300 nm) nano particles	71

Bis-GMA: Bisphenol A-glycidyl methacrylate, TEGDMA: Triethyleneglycol dimethacrylate, UDMA: Urethane dimethacrylate, UTMA: Urethane tetramethacrylate, Bis-MEPP: Bis-methacryloxyethoxy phenyl propane.

Table 2 Curing method of the materials tested in the study

Light curing Unit	Preliminary Polymerization	Final Polymerization	Heat curing condition
Estenia CS-110 Light and Heat Curing System; Kuraray Medical, Tokyo, Japan	30 s (light oven)	270 s (light oven)	100–110°C/212–230°F for 15 min (heat oven)
Epricord CS-110 Light and Heat Curing System; Kuraray Medical	30 s (light oven)	240 s (light oven)	—
Tescera Tescera ATL II processing unit (Bisco, Schaumburg, IL, USA)	4 min (pressure and light oven)	—	The inlays were postcured in a heat cup submerged in water and under a pressure at 135°C in a nitrogen atmosphere at 550 kPa. (Heat, pressure and light oven)

were prepared with dimensions are shown in Fig. 1. A high-speed hand-piece with a diamond bur (All Ceramic Preparation Kit, Shofu, Ratingen, Germany; lot number: 031420) was used to prepare the MOD inlay cavities. In all groups, margins were prepared with 90° cavosurface angles and were free from undercuts. The inner angles of the cavities were rounded, and the margins were not beveled. All measurements were made with a digital caliper (Mitutoyo, Kawasaki, Japan). Moreover, preparation depths were controlled with silicone keys and measured with a periodontal probe (Probe UNC# 12 hdl#6, Hu-Friedy, Tuttlingen, Germany). A total of 30 of these unfilled teeth (10 teeth for each cavity design) were used as a negative control group (left unfilled). Schematic presentation of the study is illustrated with Fig. 2. All preparations were performed by the same operator (N.T.) to eliminate inter-operator differences.

Estenia (Kuraray Medical, Tokyo, Japan; body A2 shade), Epricord (Kuraray Medical; body A2 shade), Tescera (Bisco, Schaumburg, IL, USA; body A2 shade), and Cerasmart CAD/CAM composite blocks (GC America, Alsip, IL, USA; body A2 shade) were used for each cavity design (n=10) (Table 1). Impressions were made with a polyvinyl siloxanes material (Express VPS, 3M ESPE), master dies (Quick Die, Bisco) were obtained for Estenia, Epricord and Tescera specimens. All indirect restoration were constructed and polymerized following the manufacturer's instructions as shown in Table 2.

For the preparation of the Cerasmart CAD/CAM specimens, a CAD/CAM device (CEREC Bluecam, Sirona Dental Systems, Bensheim, Germany) with software (COS Crown 2.1, Sirona Dental Systems) was used. COS Crown 2.1 software was used with the software selections of extrapolation and extended



Fig. 3 (a) The inlay restoration in G1. (b) The inlay restoration in G2. (c) The inlay restoration in G3.

milling. Imaging liquid (CEREC liquid, Vita Zahnfabrik, Bad Sackingen, Germany) was applied to the prepared teeth and spread to a thin film with compressed air. Imaging powder (CEREC powder, Vita Zahnfabrik) was sprayed on the prepared tooth. Powdered preparations were scanned with CEREC Bluecam. Thirty inlays were machined from post-heated, polymerized composite blocks (Cerasmart, GC America). Teeth were rinsed free of imaging powder, and the inlays were placed in their respective preparations.

Luting procedure

Before the cementation, the inner surfaces of all restorations were sandblasted with 25–50 μm alumina (0.2 MPa) and cleaned by sonicating in ethanol and air-dried. Then, all inlays were cemented with a dual-cure resin cement, Panavia F2.0 (Kuraray Medical), according to manufacturer instruction. The cement was polymerized using a LED light unit (Elipar S10, 3M ESPE) calibrated at 1,200 mW/cm^2 from the facial, lingual, and occlusal directions for 60 s in each direction. The light intensity of the curing light was checked during specimen preparation by using a radiometer (Hilux Curing Light Meter, Benlioglu Dental, Ankara, Turkey). Restoration margins were finished and polished with Sof-Lex discs (3M ESPE; Lot number: 2380). All the specimens were stored in 37°C water for 24 h (Figs. 3a, b and c).

Load to fracture

The completed specimens were loaded with a hemispherical steel indenter using a metal sphere of 8 mm-diameter applied vertically and centered on the occlusal surface of restoration. The load was applied until failure, with a universal testing machine (Instron 6022, Instron, MA, USA) at a crosshead speed of 1 mm/min (Fig. 4). The force (N) required to fracture the restoration and the mode of fracture were recorded.

Fracture analysis

Fracture analysis was performed under a stereomicroscope (×16), and the mode of fracture for each specimen was classified according to Burke *et al.*[15] as follows:

- Mode I: isolated fracture of restoration (Fig. 5).
- Mode II: restoration fracture involving a small tooth portion (Fig. 6).

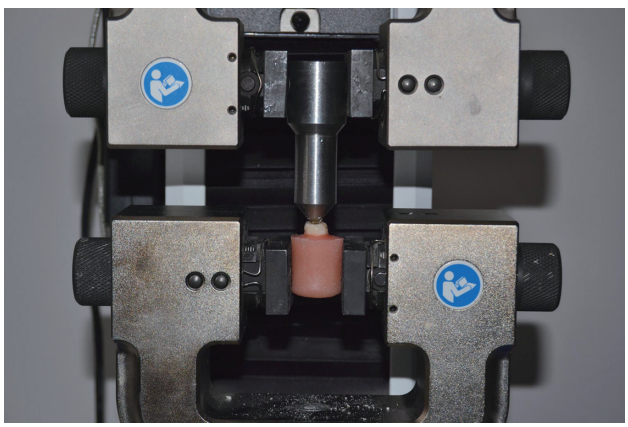


Fig. 4 Positioning of specimen in universal testing machine.

- Mode III: fracture involving more than half of the tooth, without periodontal involvement (Fig. 7).
- Mode IV: fracture with periodontal involvement (Fig. 8).

Statistical analysis

All statistical analyses were performed using IBM SPSS for Windows version 20.0 (SPSS, Chicago, IL, USA). Shapiro-Wilk tests were used to test the normality of data distribution. Continuous variables were expressed as mean±standard deviation; comparisons of cavity design and composite variables were performed using the two-way analysis of variance (ANOVA) and Bonferroni *post hoc* test. A two-sided p-value<0.05 was considered statistically significant.

RESULTS

The means and standard deviations for the fracture resistance of the test groups are shown in Table 3. The two-way ANOVA showed that there were statistically significant differences among the groups. In G1, intact teeth (2,794.6±569 N) showed higher fracture strength values than all composites except for Estenia (3040.6±304 N). Only Epricord (2,141.9±489.7 N) showed significantly lower fracture strength values than intact

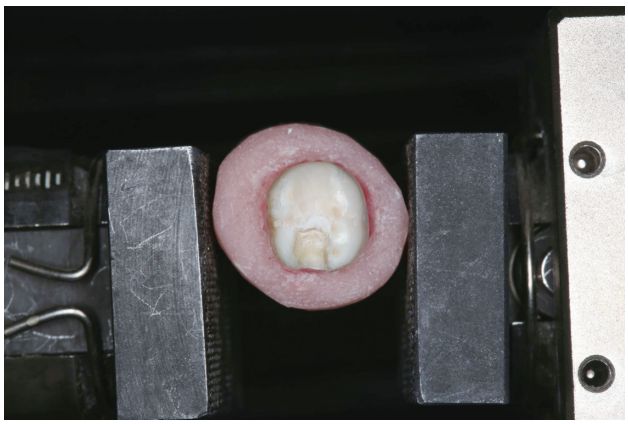


Fig. 5 Mode I fracture type.

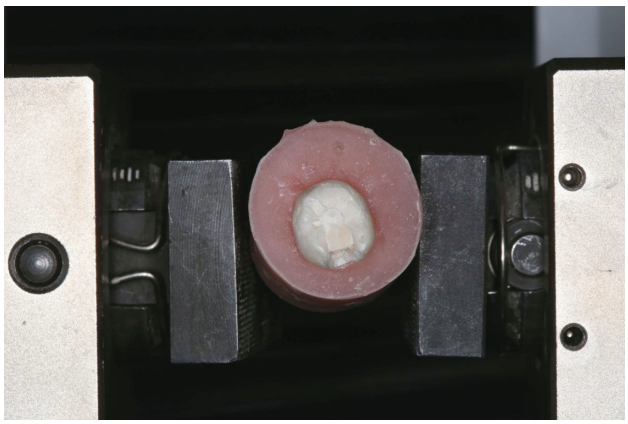


Fig. 6 Mode II fracture type.

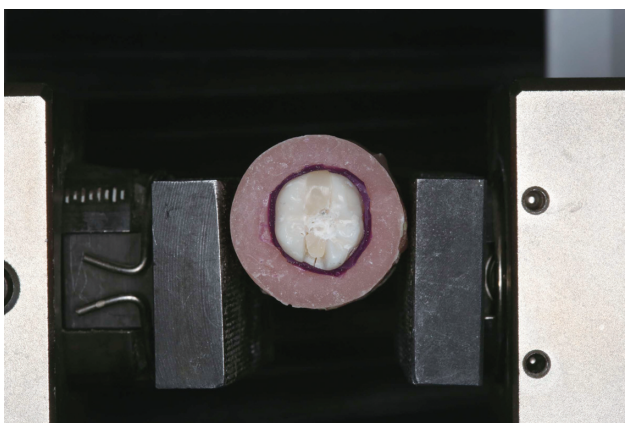


Fig. 7 Mode III fracture type.

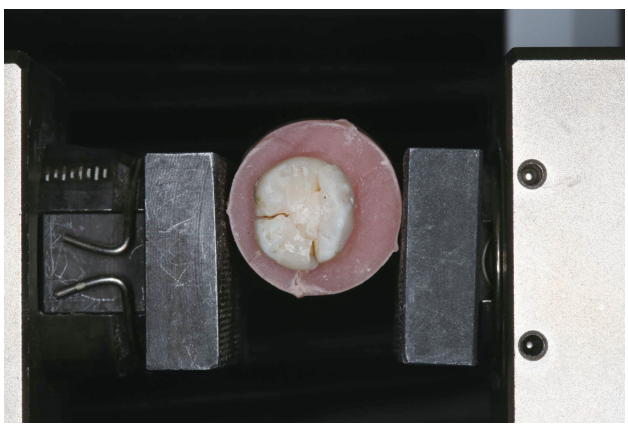


Fig. 8 Mode IV fracture type.

teeth in this group (p=0.028). Estenia (2,172.9±569.5 N; p=0.045), Cerasmart (2,012.1±375.8 N; p=0.003) and Epricord (2,043.1±315.8 N; p=0.005) in G2 and Estenia (1,992.8±470.9 N; p=0.002), Epricord (1,580.1±565.1 N; p<0.001), Tescera (2,039.8±350.6; p=0.005) and Cerasmart (1,998.3±495.1 N; p=0.002) in G3 displayed significantly lower fracture strength than intact teeth (2,794.6±569 N).

In G1, Estenia and Tescera exhibited statistically similar fracture strengths. Epricord and Cerasmart exhibited significantly lower fracture strength than Estenia (p<0.05), which displayed the highest fracture strength in all materials in this group. For G2 and G3, no significant differences were observed among the fracture strength values of Estenia, Epricord, Tescera, and Cerasmart (p>0.05). However, the highest fracture strength values were obtained for Tescera in G2 and G3.

When the specimens were examined in terms of cavity design, the highest fracture strength values were observed for the specimens in G1 followed by those in G2 and G3, for all materials tested. In addition, for the unfilled cavities (negative control group), fracture test showed that the proximal box cavity decreased the fracture strength of teeth compared to the non-proximal box cavity. In all groups, unfilled cavities showed significantly lower fracture strength values than those of intact teeth and restored teeth with restorative materials.

The fracture pattern characteristics are presented in Table 4. When the fracture modes were analyzed, the highest rate of mode III and IV was observed for the specimens in G2 and G3. In G1, more severe fractures occurred in both restoration and tooth for Cerasmart and Epricord when compared to Tescera. In G2, Estenia and Tescera mostly exhibited mode III and IV fractures. In G3, all samples of Estenia, Epricord, and Tescera displayed mode III and IV fractures.

DISCUSSION

This study was conducted to investigate how cavity design and the use of different restoration materials influence the fracture behavior of molars with MOD inlay cavities. It was demonstrated that proximal box had an impact fracture resistance regardless of the

Table 3 Mean fracture resistance (N) values and standard deviations of each restorative materials, in descending order for G1 (n=10)

Material	Non-proximal box MOD cavity (G1)	2 mm proximal box MOD cavity (G2)	4 mm proximal box MOD cavity (G3)
Estenia	3,040.6±304 Aa	2,172.9±569.5 Ab	1,992.8±470.9 Ab
Intact teeth (positive control)	2,794.6±569 ACa	2,794.6±569 Ba	2,794.6±569 Ba
Tescera	2,443.5±514.6 ABa	2,212.1±472.7 ABa	2,039.8±350.6 Aa
Cerasmart CAD/CAM	2,314.8±522.8 BCa	2,012.1±375.8 Aa	1,998.3±495.1 Aa
Epricord	2,141.9±489.7 Ba	2,043.1±315.8 Aab	1,580.1±565.1 Ab
Unfilled cavity (negative control)	982.6±145 Da	746.4±82 Ca	762.1±108.5 Ca

Means followed by distinct capital letters represent statistically significant differences in each column (comparisons of the composites for each group) (p<0.05).
Means followed by distinct lower case letters (comparisons of the groups for each material) represent statistically significant differences in each row (p<0.05).

Table 4 Mode of fracture of restored specimens according to Burke[15]

Mode of failure	Intact teeth	Estenia			Epricord			Tescera			Cerasmart			Unfilled		
		G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3
I	—	3	—	—	1	2	—	4	—	—	—	1	1	—	—	—
II	5	1	—	—	1	4	—	4	1	—	2	3	4	—	—	—
III	5	5	6	2	5	1	8	2	7	5	4	5	4	7	5	2
IV	—	1	4	8	3	3	2	—	2	5	4	1	1	3	5	8

material used, thus the first null hypothesis 'cavity type non-proximal box or proximal box extended gingivally with different depths does not affect the fracture resistance of the tooth-restoration complex' must be rejected. Estenia in G1 and Tescera in G2 and G3 exhibited highest fracture strength values. Thus, the second null hypothesis must also be rejected. Therefore, the type of restoration material affects the fracture resistance of the tooth-restoration complex. The composites that were applied to the non-proximal box cavity design exhibited higher fracture resistance than those applied to 2- and 4-mm proximal box cavities for all groups. This finding is also in accordance with the results for the unfilled cavities (negative control group). Our study also showed that all cavity designs weaken the remaining tooth structure significantly. These results are in agreement with the observations of Morin *et al.*[16], and St-Georges *et al.*[17], and Soares *et al.*[18], who reported a reduction in the fracture resistance for teeth that had been prepared with a greater removal of dental structure. Large tooth substance losses are frequent in posterior teeth because of primary caries or aging restorations. Endodontic treatment can also weaken the tooth structure. Endodontic access associated with removal of pulp chamber walls and root dentin appears to be directly responsible for the greater vulnerability of endodontically treated teeth. Preparation of an endodontic access cavity compromises the strength of the tooth because the preparation results in a deep and extended cavity, reducing the amount of dentin[19,20]. Therefore, cuspal coverage is generally desirable for the restoration of endodontically treated teeth[21,22]. Furthermore, laboratory-fabricated complete crowns or partial-veneer crowns covering all cusps were suggested to constitute the restoration of endodontically treated teeth[23]. As the purpose of the presented study was to evaluate the MOD inlay cavity design, endodontically treated teeth were not considered in terms avoiding the cuspal coverage and avoiding the reduction of the resistance that is already weakened by with deep cavity preparation.

In this study, adhesively cemented inlays strengthened the weakened tooth structure significantly by using composite materials. In agreement with the results obtained by St-Georges *et al.*[17] under compressive load testing, composite and ceramic-bonded inlay

restorations reinforce the tooth structure but do not restore the original strength of the intact teeth.

In this study, non-proximal box MOD cavity and 2-mm or 4-mm proximal box cavity exhibited statistically similar fracture strength values for Epricord, Tescera, and Cerasmart. However, Estenia exhibited significantly higher fracture strength in non-proximal box cavity than 2 or 4-mm gingivally extended proximal box cavity. Our findings were partially in agreement with the results of Liu *et al.*[24] that non-proximal box MOD cavity and 2-mm proximal box cavity exhibited similar fracture strength values for Z100 resin composite and IPS Empress CAD ceramic restorative materials. The main aims of the restorative dentistry are to restore the esthetic and function of tooth structures and also to prevent secondary caries occurrence[25]. The inherent strength of a tooth is generally dependent on the amount of remaining dentine[26,27]. Therefore, preservation of coronal dentine is important to determine the longevity of restorations. The strategic value of the remaining tooth structure and the clinical evaluation of the amount of dentine needed for functional requirements are currently based on clinical opinion[26]. Therefore, Black's guideline of extension for prevention has been changed to "prevention instead of extension"[28]. Adhesive systems allow new cavity designs to be used with composite materials because they do not require special retention forms like with amalgam restorations. In addition, deeper proximal boxes with limited or no enamel provided at the margins are more challenging clinically[29]. Therefore, maximum preservation of dental hard tissues and minimal invasive cavity designs should be selected to increase the longevity of the tooth[30].

Resin-composite restorative materials in the oral cavity are subject to different environments and cyclic fatigue[31]. Fracture occurs when the stress intensity of the material reaches the critical level at which the cracks start to grow[32]. Many possible factors like variation of testing methods, types of resin composite, temperature, length and solutions used for aging could be effective on the results[33]. There is not a specific aging or fatigue protocol in the literature for the laboratory test methods. Generally, the specimens have been subjected thermocycling[34,35] or thermomechanical loading[21,36] or stored in various liquids with various percentages[32]. However, in several studies no aging protocols were applied to specimens, some of those are presented by Liu *et al.*[24], St-Georges *et al.*[17],Soares *et al.*[18,37], and Görücü[38]. Similar to them, we did not applied an aging protocol to the specimens in the presented study, not only to avoid from a crack propagation in the restoration but also to examine the initial mechanical properties of the composite materials and keeping the results unaffected from external factors. Consequently, it was reported that the fracture of a restoration may be the culmination of a crack propagation in the restoration that is initiated by a flaw[32] and such a flaw may be produced by fatique[39].

In this study, the highest fracture strength for Estenia was determined in comparison with not only intact teeth but also all other materials for G1. Harada *et al.*[40] researched the fracture resistance of Estenia and Lava CAD/CAM system in molar crowns and reported that there was no significant difference in fracture resistance between Lava Ultimate and Estenia. Greater fracture resistance of the Estenia restorations could be attributed to the very high filler (92%) content. It is known that filler loading plays an important role in the mechanical properties of composites[41,42]. Hybrid ceramics in Estenia are also advanced composite materials with high reinforcement resistance, which is the result of the loading of a resin matrix containing a micro-filler with a high proportion of nano-filler particles. Hirata *et al.*[43] reported that the wear of Estenia was smaller than that of Epricord. In this study, the resin Epricord displayed significantly lower fracture strength than Estenia. Epricord is cured only by light, in a light curing unit, which is different from other indirect resins that make use of light and also other resources such as heat, vacuum, pressure, or nitrogen with a view to optimize the curing. Ferracane and Condon[44] reported that the use of heat for additional polymerization increases the conversion rate of monomers, reflecting in improvement of surface hardness, and compressive and flextural strength. Similarly, Klymus *et al.*[45] reported that composites polymerized under high temperatures and pressures have higher mechanical properties than those polymerized only with light. The lack of further polymerization methods for Epricord and lower filler loading could be held responsible for the relatively lower fracture strength in comparison with other tested materials.

In G2 and G3, Tescera exhibited the highest fracture strength values. Tescera is a microhybrid composite material and polymerized under heat, light, and pressure in an oxygen-free environment. Drummond *et al.*[31] proposed that the crack inhibition of the large filler particles and the bonding between them result in the observed higher fracture toughness of Tescera. Moreover, polymerization under a nitrogen atmosphere may be responsible for the enhanced properties of Tescera. The use of a nitrogen atmosphere during polymerization produces an oxygen-free environment; because oxygen is an inhibitor of polymerization, a higher degree of conversion can be achieved[46]. It has been previously shown that curing in the presence of heat and constant pressure decreased porosities in the composite bulk, leading to more homogeneous microstructures[7,8].

Nanoceramic Cerasmart is the latest pre-cured composite block for milling CAD/CAM indirect restorations. The mechanical properties of composite resin blocks fabricated using CAD/CAM systems can been hanced by applying heat polymerization under high pressure to hybrid, nanofilled, and nanohybrid composite resins[47,48]. According to Davidowitz and Kotick[49], a challenge with these systems was to ensure adequate strength of the restoration, especially for posterior teeth. In this study, in all groups, Cerasmart CAD/CAM system exhibited lower fracture strength than intact teeth. Awada and Nathanson[50] examined the mechanical properties of different CAD/CAM materials

and showed that Cerasmart, a nanoparticle-filled resin,exhibited significantly higher flextural strength and lower flextural modulus than polymer-based CAD/CAM restorative materials (Vitablocs MarkII and Paradigm MZ100). Flextural modulus indicates material stiffness, which is important because it influences composite selection in high-stress situations[11]. Mechanical properties depend mainly on composite microstructure and composition and therefore on filler amount, size, morphology, and distribution[51]. In this study, the relatively inferior mechanical properties of Cerasmart than Estenia and Tescera may be attributed to the lower filler content (71%) of the material. In similarity with Awada and Nathanson[50], Lauvahutanon *et al.*[52] examined mechanical properties of composite resin blocks fabricated using CAD/CAM and reported that among all CAD/CAM materials, Cerasmart exhibited the lowest microhardness and highest flextural strength values.

Soares *et al.*[37] stated that the indirect composite fracture patterns were mainly of mode IV and reported that the polymer materials accumulate and transmit tensions that exceed the intrinsic resistance of the dental structure. In agreement with Soares *et al.*, in this study, all the composite inlays demonstrated greater number of highly complex fractures with/without severe periodontal involvement (mode III or mode IV)(as the group of independent). In particular, Estenia had more mode III and IV fractures than Tescera and Cerasmart.

CONCLUSION

The use of deep MOD preparations severely weakens molar teeth. However, bonded inlay restorations replace the lost tooth structure and recreate the anatomic form of a prepared tooth. All materials tested in this study could be used successfully in the molar-region MOD inlay restorations. Among the composite materials used, Estenia and Tescera have shown superior results.

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