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ASSESSMENT OF FRACTURE RESISTANCE OF ENDODONTICALLY TREATED MOLARS RESTORED WITH ENDOCROWNS FABRICATED BY TWO DIFFERENT MATERIALS - IN-VITRO STUDY

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ABSTRACT

The aim of this study was to assess the fracture resistance of endodontically treated molars restored with endocrowns fabricated by pressed lithium disilicate and nanohybrid composites cemented by conventional etch and rinse resin cement.

Materials and Methods: Forty sound permanent lower second molars were assigned into four equal groups according to the restorative material used for endocrown fabrication; **Group (1):** sound molars as negative control (sound), **Group (2):** molars were endodontically treated and received occluso-mesial cavities without restorations as a positive control (unrestored), **Group (3):** molars were endodontically treated and received occluso-mesial cavities restored using lithium disilicate endocrowns (LDS) and **Group (4):** molars were endodontically treated with occluso-mesial cavities restored using nanohybrid composite endocrowns (NRC). Endocrowns were fabricated and cemented using conventional resin cement. Fracture resistance of all groups was evaluated using universal testing machine.

Results: One-way ANOVA showed a statistically significant difference between groups with $p< 0.001$. Sound teeth recorded the highest mean fracture resistance sound teeth recorded the highest mean fracture resistance (2064.29 ± 446.25 N), followed by NRC group (1831.03 ± 403.09 N) then LDS group (1551.54 ± 153.70 N), with statistically insignificant difference between the three groups. While unrestored teeth recorded the least statistically significant mean fracture resistance(632.15± 247.61 N).

Conclusions: Fracture resistance of both nanohybrid resin composite endocrowns and lithium disilicate endocrowns was similar to that of intact teeth. **Clinical relevance:** Nanohybrid resin composite endocrowns and lithium disilicate endocrowns can be used to restore ETT with occlusomesial cavities.

KEYWORDS: Endocrown, Lithium disilicate, Nanohybrid resin composite, Fracture resistance.

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INTRODUCTION

Endodontically treated teeth (ETT) exhibit changes in biomechanical as well as neuroreceptive behavior when compared to vital teeth. Pulp tissue removal leads to dehydration, demineralization, reduction in proprioceptors and alteration in collagen content[1]. The prognosis of ETT is affected by many factors; remaining tooth structure, number of adjacent teeth, occlusal contact, dehydration and collagen degradation[2]. Moreover, type of restoration significantly influences the long-term survival of teeth[3].

Resistance to masticatory loads is greatly dependent on the amount of the residual tooth tissue[2,3]. Scotti et al., 2015,[1] found that the main factors compromising structural resistance of endodontically treated teeth are marginal ridges loss, cusp thickness reduction; associated with caries or traumatic fractures, in addition to essential clinical procedures needed to perform endodontic treatment; as demineralized coronal tissue removal and deroofing of the pulp chamber.

The rehabilitation of ETT remains a challenge among clinicians due to the extensive loss of coronal tooth structure[6].The traditional method to restore those structurally compromised root canal treated teeth is to use post, core and crown restorations[7]; following the belief that this treatment modality offers better reinforcement for the residual tooth structure[8,9].

Although, studies have found that adding a post helps only to retain the core. Some drawbacks have been associated with using a post such as weakening of the remaining tooth structure caused by intracanal post preparation as well as the risk of procedural errors during its placement, such as strip perforations[10-12]. Moreover, Heydecke et al., 2001[13], reported that root fractures incidence increases with the use of post placement.

Ferrari et al., 2019[14] suggested that the clinical performance of lithium disilicate partial crowns restoring endodontically treated molars and premolars was neither affected by the use of fiber post nor the type of tooth to be restored. Moreover, Fokkinga et al., 2007[15], concluded that different core restorations used did not show any difference in survival rates of ETT. A 17 years follow up suggested that in ETT, post retained cores did not perform better than post free cores. Preservation of remaining tooth structure was also found critical for long term survival of endodontically treated crowned teeth[15].

The evolution of minimally invasive dentistry with the advancement of adhesive techniques came to challenge the post and core concept[16]. Endocrowns were originally defined by Pissis in 1995[17] as a monoblock porcelain core and crown unit. Later on, the term "Endocrown" was introduced by Bindl and Mörmann in 1999[18]. Endocrown describes a single unit restoration consisting of a core and crown, extending into the pulp chamber to restore ETT. Retention of endocrowns is gained macro-mechanically through the axial walls of the pulp chamber and micro-mechanically through the adhesive resin cement. Consequently, materials such as glass ceramics, lithium disilicate and composites having the capability of bonding to tooth structure through resin cements, have been suggested for endocrowns construction[5].

Endocrowns are indicated in cases of endodontically treated posterior teeth with increased loss of coronal tooth structure, particularly those having obliterated or short roots, along with cases of reduced interocclusal space[19]. Endocrowns offer the benefit of being a more conservative option as they involve removing minimal amount of healthy tooth structure compared to alternative methods[20].

Another benefit is the more effective dissipation of masticatory forces at the tooth/ restoration interface and throughout the restored tooth structure[20]. Being conservative, less technique sensitive and more practical, endocrowns showed not only comparable but also superior results to that of traditional treatments using post, core and crown or inlay/ onlay restorations[12]. According to the findings of Sedrez-Porto et al., 2016[21], endocrowns demonstrate similar or superior performance when compared to treatments utilizing intraradicular posts, direct composite resin, or indirect restorations like onlay/inlay.

Endocrowns were originally constructed of glass ceramic.[1] Lithium disilicate has adequate mechanical strength and esthetics[22]. Ceramics offer better esthetics and less plaque retention than composites[23], yet they present catastrophic failures. Root extending fractures have been reported in ceramic endocrowns due to their increased stiffness and brittleness[24].

Nano-filled composite has a modulus of elasticity comparable to that of dentin, which helps to maintain high fracture resistance, thereby reducing the number of irreparable fractures[23]. On the other hand, this similarity in modulus of elasticity between nano-filled composite and dentin, increases stresses at the cement interface due to difference in modulus of elasticity of the cement. Consequently, this leads to increased risks of debonding of composite endocrowns[24]. According to Govare et al., 2020[23]., the fracture resistance of various materials exceeded the forces exerted during mastication. This suggests that materials with stronger adhesion properties are the best choice, as the risk of debonding was higher than the risk of fracture. The increased adhesive interface continues to pose challenges for indirect restorations. Indirect restorations remain challenging due to the increased adhesive interface[25].

Resin cement is typically used for luting brittle ceramics and indirect composite restorations[26]. Adhesion can be achieved by resin cements through mechanical interlocking as well as chemical bonding through indirect restoration silanization. Impregnation of resin cement in irregularities created in the fitting surface of the endocrowns results in greater bond strength and fracture resistance[25].

Currently, indirect resin composite materials have been proposed as a potential substitute to ceramic materials. Considering their greater biomimetic properties, easy repair, as well as being less abrasive to the opposing[22]. However, there were only few studies assessing the fracture resistance of endodontically treated molars restored by resin composite endocrowns. Thus, this study was held to assess the fracture resistance of endodontically treated molars restored with endocrowns fabricated by pressed lithium disilicate and nanohybrid composites cemented by conventional resin cement. The null hypothesis of the current study was that There will be no difference between fracture resistance of endodontically treated teeth restored by nanohybrid resin composite endocrowns and lithium disilicate endocrowns.

MATERIALS AND METHODS

Sample Size Calculation

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference would be found in fracture resistance between different groups. By adopting an alpha level of (0.05) a beta of (0.2) i.e. power=80% and an effect size (f) of (0.610) calculated based on the results of Altier et al., 2018[22], and Al shibri and Elguindy, 2017[27]. The predicted sample size (n) was a total of (36) samples (i.e. 9 samples per group). Sample size calculation was performed using G*Power version 3.1.9.7.

Teeth Selection and Grouping

This study was approved by the research ethical committee of Misr International University, with code "MIU- IRB- 2122-14". To account for possible failures in samples during this in vitro study, a total of 40 intact and sound lower second molars that were extracted for periodontal reasons, with complete root formation, nearly similar size and morphology were collected for the current study. Remnants as dental plaque, calculus or any organic tissues were removed using ultrasonic scaler(26, 27). All molars stored in normal saline at room temperature for no more than one month until used. Teeth were randomly assigned into four equal groups (n=10) according to the material used for endocrown fabrication. Material's composition, manufacturer and Lot number are presented in **Table (1)**.

Group (1): Sound permanent molars (negative control). Group (2): Endodontic access cavity, endodontic treatment and occluso-mesial cavities (positive control). Group (3): Endodontic access cavity, endodontic treatment, occluso-mesial cavities and lithium disilicate endocrown (LDS). Group (4): Endodontic access cavity, endodontic treatment, occluso-mesial cavities and nanohybrid composite endocrown (NRC). Each tooth of LDS group was scanned using digital intraoral scanner (Medit I500, Medit corp., Seoul, Korea) and transferred to the software database (DentalCAD Galway 3.0, exocad GmbH, Germany) to be used later to restore the original anatomy of teeth **(Figure 1-A).** While Silicone putty impression (Zetaplus, Zhermack SpA, Badia Polesine (RO), Italy) was taken for each tooth of LDS and NRC groups to serve as an occlusal index to assess the amount of tooth reduction for both groups and to restore the original anatomy of teeth in NRC group. (29, 30). **(Figure 1-B)**

Endodontic Treatment

Teeth of unrestored, LDS and NRC groups were accessed using #2 round stone and round end tapered stone (Mani, Utsunomiya, Japan). K file #15 (Mani, Utsunomiya, Japan) was used for working length

TABLE (1) Material's composition, manufacturer and Lot number.

Character	Materials	Composition	Manufacturer	Lot no.
Lithium disilicate	IPS Emax press HT A2	SiO_2 (57%--80% wt), Li_2O (11%-19% wt) K_2O, P_2O_5, ZrO_2, Other oxides and ceramic pigments.	Ivoclar Vivadent	Z02HG1
Nanohybrid resin composite	Grandio A2	Bis-GMA, TEGDMA, Fillers (87% wt): ariumeboron-alumino-silicate glass (0.1-2.5 um), Silica(20-60 nm).	VOCO	2204312
Conventional resin cement	Bifix QM	Bis□GMA, benzoylperoxide, amines, barium-aluminiumboro- silicate glass (71-73% wt).	VOCO	2128700

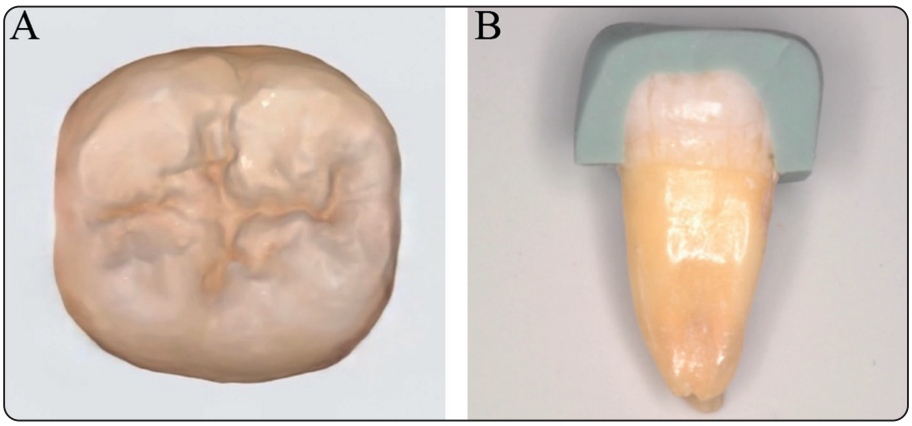

Fig. (1): (A) Preoperative scan for group (3), (B) preoperative occlusal index LDS and NRC groups determination with radiograph. All canals were instrumented using rotary files (Protaper Universal, Dentsply, USA) up to #F3 while maintaining patency with #10 K file (Mani, Utsunomiya, Japan) and irrigated with 5.25% sodium hypochlorite after each file[22]. Canals were dried using paper points (Absorbent Paper Points, Meta Biomed, Chungcheongbuk-do, Korea) and obturated using Gutte percha (Gutta Percha Points, Meta biomed, Chungcheongbuk-do, Korea) and root canal sealer (ADSEAL, Meta Biomed, Chungcheongbuk-do, Korea).

Samples preparation

After endodontic treatment, samples were embedded in self-cure acrylic resin blocks (Coltene, Egypt), with no periodontal ligament simulation. Cylindrical teflon molds with 2.5 cm height and 1.5 cm internal diameter, were used to support the acrylic resin with the tooth embedded inside it. While the acrylic was in the soft dough stage, roots were pressed perpendicularly in the acrylic resin 2 mm above the CEJ. After complete setting of the acrylic, the whole block was pushed out of the mold[31,32].

Cavity preparation

All samples of unrestored, LDS and NRC groups received a standardized occluso-mesial cavities. Access cavities were extended to the mesial fossae using fissure bur (Mani, Utsunomiya, Japan) at high speed. Mesial boxes were prepared with a gingival seat 1 mm above the CEJ. The widths of the mesial boxes were prepared to be 4 mm cervically and 5 mm occlusally using tapered fissure bur and inverted cone bur (Mani, Utsunomiya, Japan). Dimensions of the mesial box were confirmed using a periodontal probe. LDS and NRC groups were prepared to receive endocrowns; buccal and lingual cusps were reduced 2 mm using wheel stone (Mani, Utsunomiya, Japan)[29,30]. The amount of the occlusal reduction was confirmed using the silicon index. Gutta percha was removed to a depth of no more than 2 mm below the orifice of each canal using small carbide round bur[33, 34]. The pulp chamber walls were prepared to establish an occlusal divergence with 8° to 10° using 8° angled diamond stone with round end (Mani, Utsunomiya, Japan). Thickness of the walls was checked, using a manual metal caliper, to be 2.0 ± 0.2 mm[22].

Scanning of teeth

Each prepared tooth of LDS and NRC groups was scanned using digital intraoral scanner (Medit I500, Medit corp., Seoul, Korea). The resulting 3D scans were imported on a software (Medit Model Builder, Medit corp., Seoul, Korea) where the casts were designed with each cast having its corresponding number and exported as standard tessellation language (STL) file format 3D printed cast was fabricated for each tooth using a 3D printer (form 3B, Formlabs, Somerville, MA, USA) and model resin (V2, Formlabs, Somerville, MA, USA)[35].To obtain 3D printed casts with the best mechanical characteristics, accuracy, and precision, the casts were rinsed, according to manufacturers' instructions, with isopropyl alcohol (IPA, 90%) using a washing unit (Formlabs Inc., Somerville, MA, USA) until the uncured resin was thoroughly cleansed and post-cured using a curing unit (Form Cure, Formlabs Inc., Somerville, MA, USA).

Lithium disilicate (LDS) endocrowns Fabrication

All restorations were designed using CAD/CAM software (DentalCAD Galway 3.0, exocad GmbH, Germany) with the original anatomy of each tooth that was previously stored in the database[36, 37]. The design parameters were set to be 2 mm occlusal surface thickness from buccal and lingual cusps and 80 µm cement space[27]. Wax patterns were milled. Lithium disilicate endocrowns were fabricated using heat press technique where wax patterns were sprued and invested. The wax was eliminated, the pressing furnace was preheated to 700°C and the IPS

Emax ceramic ingots (IPS e-max press HT, Ivoclar Vivadent AG, Schaan Liechtenstein) was pressed at 920 °C to produce IPS Emax endocrowns. Each endocrown was separated, finished, polished and glazed.

Nanohybrid composite (NRC) endocrown fabrication

Four coats of a 20 µm die spacer (die: master blue, Renfert, Germany) were coated on the fitting surface of each 3D printed cast. The fitting surfaces of the 3D printed casts with separating medium (Acrostone Seperating Medium, Acrostone, Egypt), 2 mm thick increments of Nano-hybrid resin composite (Grandio, VOCO, Germany) were applied until building the entire shape with the original anatomy and dimensions for each tooth using the silicon index. Each increment was light cured for 20 seconds using LED light curing unit (Elipar S10, 3 M ESPE, St Paul, MN, USA) with light intensity of 1200 mW/cm^2. The endocrowns were initially removed after the first curing stage and then subjected to additional dry heat curing in a curing oven with multidirectional curing at 80˚C for 10 minutes[38, 39]. Composite Endocrowns were finished and polished.

Surface Treatments:

a. Surface treatment of tooth structure

Prepared tooth surfaces were etched using 37% phosphoric acid (Meta Etchant, Meta Biomed, Chungcheongbuk-do**,** Korea) for 20 seconds for enamel and 15 seconds for dentin, then rinsed for 20 seconds and dried using cotton pellets. Thin layer of total-etch adhesive (Solobond M, VOCO, Cuxhaven, Germany) was applied and light cured for 20 seconds[22,26].

b. Surface treatment of Lithium disilicate endocrowns

The fitting surface of lithium disilicate endocrowns were etched using 9.5% hydrofluoric acid (Porcelain Etchant, Bisco,Inc.Schaumburg,IL, USA) for 20 seconds then rinsed for 60 seconds and dried well. Followed by application of a silane coupling agent (Porcelain Primer (Pre-Hydrolyzed Silane Primer), Bisco, Inc.Schaumburg, IL, USA) for 60 seconds[22].

c. Surface treatment of Nanohybrid composite

The Fitting surfaces of nanohybrid composite endocrowns were sandblasted using 50 µm aluminum oxide particles for 10 seconds using an air abrasion device (Bio-art Micro Jato, Bio-art Equipamentos Odontologicos LTDA, Brazil). Consequently, silane coupling agent (Porcelain Primer (Pre- Hydrolyzed Silane Primer), Bisco, Inc.Schaumburg, IL, USA) was applied for 60 seconds[22, 34].

Seating and bonding of endocrowns:

All endocrowns were cemented using conventional dual cure resin cement (Bifix QM, VOCO, Cuxhaven, Germany). The cement was coated on the fitting surfaces of endocrowns. Endocrowns were seated on its assigned tooth with light pressure. Excess cement was removed from the margins after 2 seconds of initial polymerization, followed by light curing at occlusal, buccal, lingual, mesial and distal directions for 20 seconds for each side. Eventually, restoration margins were finished and polished[22, 34].

Fracture resistance test:

All samples were subjected to fracture resistance test using universal testing machine (Instron model 3345, England). Tightening screws were used to fix the samples on the lower compartment of the testing machine. While the movable upper compartment contained a 6 mm diameter stainless steel ball applying a static axial load directed perpendicular to the long axis of the tooth at a speed of 1mm/ min until fracture[22,29,30] **(Figure 2).** Maximum force needed for fracture was recorded in Newton (N) using the machine software (BlueHill universal, Instron, England).

Fig. (2) Static load application perpendicular to long axis of the tooth.

Statistical Analysis

Categorical data are presented as frequency and percentage values and were analyzed using chi-square test followed by pairwise comparisons utilizing multiple z-tests with Bonferroni correction. Numerical data are presented as mean and standard deviation values. They were checked for normality using Shapiro-Wilk's test. Data showed parametric distribution and were analyzed using independent t-test and one-way ANOVA followed by Tukey's post hoc test. The significance level was set at p≤0.05 within all tests.

RESULTS

Intergroup comparison, mean and standard deviation (SD) values of fracture resistance are presented in **Table (2)** and **Figure (3).** There was a significant difference between different groups (p<0.001). The highest value was found in sound samples (2064.29±446.25), followed by NRC (1831.03±403.09), then LDS (1551.54±153.70), while the lowest value was found in unrestored samples (632.15±247.61). Post hoc pairwise comparisons showed unrestored samples to have significantly lower value than other groups (p<0.001).

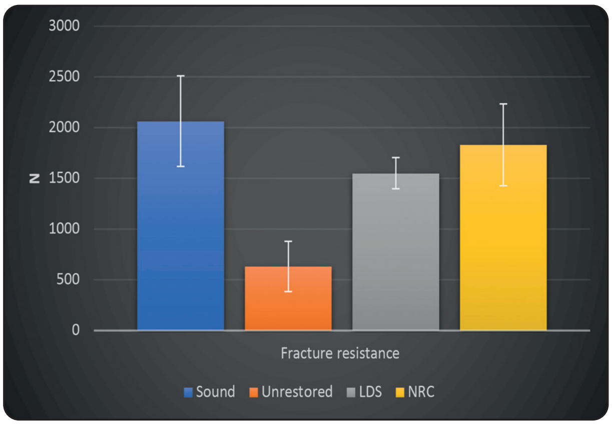

Fig. (3) A bar chart representing mean fracture resistance (N) of all tested groups.

TABLE (2) Intergroup comparison, mean and standard deviation (SD) values of fracture resistance.

Fracture resistance (N) (mean±SD)				p-value
Sound	Unrestored	LDS	NRC	
2064.29 ± 446.25^{A}	632.15 ± 247.61^{B}	1551.54 ± 153.70^{A}	1831.03 ± 403.09^{A}	**<0.001***

Means with different superscript letters within the same horizontal row are significantly different

****significant (p≤0.05)***

DISCUSSION

Endocrowns are considered a more conservative treatment which requires less chair time and can be used in teeth with short, obliterated or dilacerated roots and with limited interocclusal space[40]. The monoblock nature of endocrowns aids in dissipation of masticatory forces along the tooth structure more evenly than conventional restorations[21]. Depending on the type of material used, the whole system can either exhibit higher rigidity than the natural tooth structure in case of ceramic restorations or become biomechanically similar to the tooth structure in case of resin composite restorations[41]. As a result, the choice of material significantly influences the performance of endocrowns. Therefore, In the present study the fracture resistance of endodontically treated molars restored with endocrowns fabricated by pressed lithium disilicate and nanohybrid composites cemented by conventional etch and rinse resin cement was evaluated.

Lithium disilicate glass ceramics are the most desirable materials for endocrowns due to their high fracture strength, flexural strength (440 MPa), modulus of elasticity (95 GPa), esthetics as well as their ability to be etched by hydrofluoric acid. In the lost wax technique, a ceramic furnace is used to heat press the lithium disilicate ingots after burning out of wax pattern[42]. It was reported that lithium disilicate exhibit superior adaptation when employing the heat pressing technique for fabrication of full/ partial crowns and inlays[43,44]. Consequently, Heat pressed lithium disilicate e-max ingots (IPS e-max press HT, Ivoclar Vivadent AG, Schaan Liechtenstein) were used in the current study.

Nevertheless, it was claimed that the main drawbacks of lithium disilicate ceramics are their high elastic modulus as well as their brittleness.[45] Nanohybrid resin composite reported sufficient fracture strength due to its high filler content, which allows nanocomposite to develop superior physical as well as mechanical properties, thus aids in reinforcement of remaining tooth structure[46]. Accordingly, the present study used a nano-hybrid resin composite (Grandio, Voco, Germany) with a high filler percentage (87% w/w).

Miotti et al., 2020[47], conducted a systematic review and meta-analysis which concluded that a higher adhesive performance to dentin was related to conventional rather than self-adhesive resin cements. Dentin hybridization necessitates the development of a hybrid layer through superficial demineralization, with subsequent resin monomer infiltration and polymerization, resulting in micromechanical retention. Conversely, the self-etch process dissolves and incorporates the smear layer into the hybrid layer rather than removing it. Dual cure resin cements provide more working time along with controlled polymerization[48]. Consequently, dual cured conventional resin cement (Bifix QM, VOCO, Cuxhaven, Germany) with total-etch bonding protocol was used in the present study.

Results of the present study showed a statistically significant difference between groups ($p<0.001$), where sound teeth presented the highest mean fracture resistance followed NRC then LDS with insignificant difference between the three groups. However, mean fracture strengths of sound and both endocrown test groups exceeded that of human masticatory forces which ranged around 600 N for females and 900 N for males[22]. On the other hand, unrestored teeth showed the least statistically significant mean fracture resistance. Consequently, the null hypothesis of the present study was accepted.

This was in agreement with Abed et al., 2022[28], Sedrez-Porto et al., 2020[34], and Sedrez-Porto et al., 2019[49]**,** who reported that nanohybrid resin composite endocrowns and nanocomposite endocrowns presented higher fracture resistance than pressed lithium disilicate endocrowns. This might be attributed to the high filler loading (87%w/w) as well as the nanosized silica particles (40 -50 nm) of the nanohybrid composite used in the current study which increased its mechanical properties such as flexural strength, tensile strength, fracture toughness as well as modulus of elasticity compared to other composites. Those nanofillers act as stoppers that hinder crack propagation. Therefore, a better resistance of occlusal loads can be observed with this nanohybrid composite. Resin composites exhibit less modulus of elasticity and higher resilience compared to ceramics. Thus, during application of forces, resin composites undergo more stress absorption and elastic deformation. On the other hand, ceramics having high modulus of elasticity, show brittleness and crack formation due to its less susceptibility to deformation. Moreover, the additional heat curing of nanohybrid resin composite with higher filler loading led to a higher conversion rate up to 85%, consequently, a further increase in the microflexural strength, mechanical properties and stability[49, 50].

On the contrary to our findings, Altier et al., 2018[22], concluded that pressed lithium disilicate endocrowns showed a statistically significant higher fracture resistance when compared with both indirect microhybrid composite endocrown groups. The difference in results from our study might be attributed to the discrepancy between the composite resin structure used such as less filler loading of microhybrid resin composite as well as the lack of additional polymerization. De Kuijper et al., 2019[51], showed higher results of fracture resistance of CAD/ CAM lithium disilicate endocrowns than that of direct microhybrid composite build ups with statistically insignificant difference between both groups. Possible explanation could be the use of machinable ceramic blocks as well as direct technique of microhybrid resin composite build up. Direct-use composites exhibit polymerization shrinkage as well as limited degree of conversion, which affects the survival and fracture resistance of restorations. Also, thermomechanical aging performed before fracture resistance testing might influence the results.

Unrestored teeth showed the least statistically significant mean fracture resistance among the other groups. Those results were in agreement with Mosallam et al., 2019[29], and Haridy et al., 2022[30], who also used unrestored teeth as a positive control which showed the least statistically significant fracture strength among all the groups. This could be attributed to the poor structural integrity of the unrestored endodontically treated teeth in the current study which greatly affect their fracture resistance. Loss of tooth structure has been associated with decreased tooth stiffness and increased fracture risk of posterior endodontically treated teeth. Loss of one or both marginal ridges result in high cuspal flexure and reduction in tooth stiffness which eventually leads to increased susceptibility to tooth fracture[52].

Some limitations have been associated with the current study as it may not accurately represent the clinical situation. First, the periodontium biomechanical characteristics were not considered since previous research have concluded that periodontal ligament may serve as shock absorber and potentially have a positive effect on fracture resistance. Second, the forces applied in this study were standardized in terms of speed and direction, while intraoral forces can vary significantly in their direction, magnitude as well as speed. Third, it is worth noting that aging using thermocycling was not employed in all the groups in this study. Eventually, future clinical research is needed to evaluate the relevancy of such aging methods and assess the performance of the endocrown materials included in this study using both axial and lateral dynamic loads.

CONCLUSIONS

Under the parameters of the present study, it was concluded that:

1) Fracture resistance of both nanohybrid resin composite endocrowns and lithium disilicate endocrowns was similar to that of intact teeth.

2) Nanohybrid resin composite endocrowns showed comparable fracture resistance to that of lithium disilicate endocrowns.

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