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INFLUENCE OF DEEP MARGINAL ELEVATION ON FRACTURE RESISTANCE OF ENDOCROWN RESTORATIONS CONSTRUCTED FROM TWO (CAD/CAM) BLOCKS (AN IN-VITRO STUDY)

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ABSTRACT

Objective: To assess the impact of fracture resistance on the marginal adaptation of endodontically treated teeth restored with endocrowns fabricated from two CAD/CAM ceramics in an in vitro model.

Material and Methods: Forty sound mandibular first molars underwent endodontic treatment and were prepared for endocrowns with a butt-joint occlusal edge and a mesial proximal box. The teeth were categorized into two groups (n=20 each) according to ceramic type: Group H (hybrid ceramic) and Group L (LDS ceramic). Each group was further partitioned into subgroups E (exhibiting marginal elevation) and N (lacking marginal elevation), with 10 specimens each. The endocrowns were affixed with dual-cured self-adhesive resin cement and subjected to 5000 thermal aging cycles ranging from 5°C to 55°C. All specimens were thereafter submitted to a fracture resistance test using universal testing equipment. The gathered data was documented, organized, and submitted for statistical analysis.

Results: The LDS ceramic subgroup with deep marginal elevation (LE) exhibited considerably greater fracture resistance compared to all other evaluated subgroups ($P < 0.001$).

Conclusion: In comparison to LDS IPS E.max, hybrid ceramics, both with and without marginal elevation, demonstrate enhanced fracture resistancemarginal elevation exhibit superior Fracture resistance.

KEYWORDS: CAD/CAM Technology, Ceramics, fracture resistance, Endocrown, Endodontically Treated Teeth,

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INTRODUCTION

A significant difficulty remains for most dentists before they can be positive about rehabilitating endodontically treated teeth with substantial coronal damage. The biomechanical principles of retention and resistance are deteriorating. The biomechanical alterations resulting from root canal therapy and the extent of destroyed dental tissue necessitate restorative treatment planning by doctors.[1]

Teeth that have had endodontic treatment are often compromised in strength due to the loss of dental structure resulting from carious lesions, restorative procedures, access cavity preparation, and both essential and superfluous flaring of the root canal in the cervical region. The loss of moisture in the dentinal of these teeth purportedly leads to diminished resilience, which has been linked to a heightened risk of breakage.[2]

The enduring success of endocrowns relies on several aspects, including optimal case selection, accurate preparation, and the selection of suitable ceramic and bonding chemicals. Restorations of endodontically treated teeth must provide optimal functionality. The depth of the cavity (intracoronal extension) influences the retention and stabilization of endocrown restorations, as well as the internal cavity volume, cavity surface area, and marginal-internal adaptation. [3]

Fracture resistance and marginal adaptation are essential factors for the long-term efficacy of coronal restorations, and the intrinsic limits of several restorative materials need the continuous exploration of alternatives that might yield superior results.[4]

The tooth preparation for an endocrown must adhere to particular requirements, similar to any other restoration. A total decrease of 2 mm in height is required. A butt joint margin of 1–1.2 mm is recommended, albeit not necessarily necessary. All cervical margins should be positioned as supragingivally as feasible. An occlusal divergence of 5–7° is essential for the continuity of the coronal pulp chamber and the endodontic access cavity.[5]

Modifications may be implemented for aesthetic, biomechanical, and material-related reasons. These aberrations encompass a reduced reduction in the axial height of the cusps. Despite the enhanced fracture resistance resulting from the use of The ferrule has been scientifically recorded, and its design contradicts the principles of minimally invasive dentistry.[6]

Proximal sub-gingival margin is a difficult location for restoration as it is challenging to adequately isolate this area for a good digital impression and to perform acceptable cementation of indirect restorations.[7] The relocation of the gingival margin of his proximal cavity using a composite resin base has long been investigated. Since first described by Dietschi and Spreafico in 1998 ;[8] this procedure known as deep marginal elevation improves bonding, marginal seal and adaptation of indirect restorations. Moreover, it allows better optical impressions which leads to an increase in marginal and internal fit of the restoration; decreasing the risk of microleakage and recurrent caries. In addition many studies have shown it to decrease cusp deflection, elevate fracture resistance and improve cuspal reinforcement. [9]

The null hypothesis of this study posits that the difference in fracture resistance among restored endodontically treated teeth with CAD/CAM ceramic endocrowns will fall within the Marginal Elevation, indicating a lack of clinical evidence for any specific group.

THE AIM OF THE STUDY

Assess the impact of deep marginal elevation on fracture resistance in endodontically treated teeth replaced with endocrowns made from two CAD/CAM ceramics in an in vitro model.

MATERIALS AND METHODS

This study was conducted at the Prosthodontics Department laboratory at the Faculty of Dentistry, Minia University, with the consent of the Ethical Committee, Faculty of Dentistry, Minia University, No. (EC Ref No.504).

The sample size was determined utilizing GPower version 3.1.9.2. The equation is:

$$N= \frac{(r+1)(Z_{a/2}+Z_{1-\beta})^{2\,\sigma 2}}{rd^2}$$

Where Z_a is the normal deviate at a level of significance and $Z_{1-\beta}$ is the normal deviate at 1-8%6 power with 1-β% Power with β% of type II error.

Forty-four entire mandibular molars exhibiting full root development and comparable crown dimensions (assessed at the cementoenamel junction for buccolingual and mesiodistal widths) were gathered. Teeth removed for periodontal purposes were devoid of caries, fractures, or resorptive anomalies and were examined under 25x magnification for imperfections. The specimens were sanitized with 5% sodium hypochlorite, debrided of calculus and soft tissue, and preserved in 0.1% thymol solution. Measurements of each tooth's buccolingual, mesiodistal, and root lengths were obtained using a digital caliper and evaluated by ANOVA to confirm consistency. Specimens outside the specified range were substituted.

Endodontic treatment:

Three steps were taken in the endodontic therapy process.

Access cavity, pulp extirpation:

A preoperative periapical x-ray was conducted at the beginning of the examination to identify any deviations in root canals and to prevent internal fractures or resorption. The cavity access was achieved by removing the roof of the pulp chamber, and the orifices were clearly removed and exposed.

Canal instruments:

The glide route was established using a size 15 K-type file, with 10 K-type files added based on the canal length. The first periapical radiograph indicated the working length as being half to one millimeter from the apical constriction. The filling procedure proceeds with the utilization of size 20 and subsequently size 25 k-type files.

The root canals were treated with Pro-Taper Universal devices in the sequence of SX, S1, S2, F1, and F2, employing an adjustable-torque motor. After each tool change, the root canals were irrigated with 2 mL of 1% sodium hypochlorite solution. Subsequent to instrumentation, each canal was irrigated with 5 mL of 17% EDTA and 5 mL of sodium hypochlorite, followed by drying with paper points.

Canal obturation:

The master cone, positioned within the canal to achieve the requisite operational length, was prepared for insertion into the canals. To guarantee sufficient operational length insurance, the primary gutta-percha cone was inserted into the canal. An Adseal sealer was utilized to facilitate the obturation operation. The F2 cone was coated with sealant and inserted into the canal. A heated burnisher was employed to eliminate the extruded gutta-percha. Finally, a post-operative periapical x-ray was conducted to ensure proper root filling therapy.

Mounting into acrylic resin and grouping of specimens: -

Forty-four intact mandibular first molars were subjected to endodontic treatment and subsequently immersed in acrylic resin 4 mm apical to the cementoenamel junction (CEJ). Specimens were constructed with a butt-joint occlusal edge and mesial proximal box, thereafter categorized into two groups: Group H.

Hybrid ceramic, Grandio, and Group L, LDS ceramic, IPS e.max. Each group was also divided into subgroups E (exhibiting marginal elevation) and N (lacking marginal elevation), with 10 specimens each. The assessment of marginal adaptation was conducted utilizing a stereomicroscope. Teeth were affixed in epoxy resin using a parallometer for accurate alignment, guaranteeing the cementoenamel junction was positioned 2 mm coronal to the resin surface. The resin was combined, placed into a Teflon cylinder, and polymerized, following which the teeth were extracted for preparation and evaluation. Figure 1

Study Group Distribution

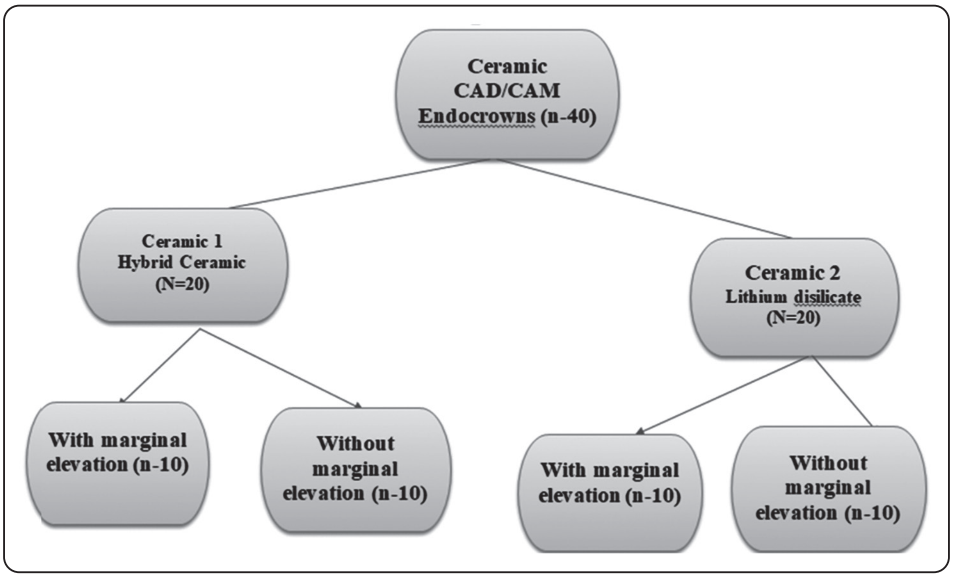

Fig. (1) Distribution of specimens among various study groups.

Endocrown and proximal box preparation:

The occlusal preparation necessitated a minimum reduction of 2 mm, directed by depth orientation grooves and a diamond wheel bur to establish a flat cervical edge 2 mm above the cementoenamel junction (CEJ). The pulpal floor was preserved to safeguard the canal entry, while 2 mm of gutta-percha was excised to employ the saddle-like configuration of the pulp chamber. A cylindrical-conical diamond bur produced a 10° coronal divergence, achieving a 3 mm pulp chamber depth and a 2 mm cervical band, while minimizing enamel loss to maintain chamber wall thickness. Refined burs polished and smoothed the surface, eradicating micro-irregularities. The pulp chamber underwent ultrasonic cleaning, and undercuts were safeguarded prior to the application of adhesive and flowable resin. The cervical floor of the proximal box was elevated 2 mm coronally to the cementoenamel junction by deep marginal elevation, including phosphoric acid etching, application of a bonding agent, and light-curing. IPS Empress Direct composite was utilized to raise the mesial margin, then contouring with a subgingival matrix and polishing with fine-grain burs.[10]

Endocrowns fabrication:

CAD/CAM software packages (Ceramil, Mind, DENTSPLY, and Sirona) were utilized for scanning and acquiring 3D pictures of the prepared teeth, which were then displayed on the computer screen. CEREC Omnicam 444, manufactured by DENTSPLY Sirona, utilized for scanning purposes. Figure (2) illustrates the utilization of an automated margin finder for the detection of preparation margins subsequent to the software's generation of a virtual model from the scanned pictures. The copy function was facilitated by the CAD/CAM software system and the biogeneric; the scanned unprepared tooth was linked to the preparation to generate a virtual crown and endocrown that replicates the tooth morphology prior to preparation, as seen in figures (3).

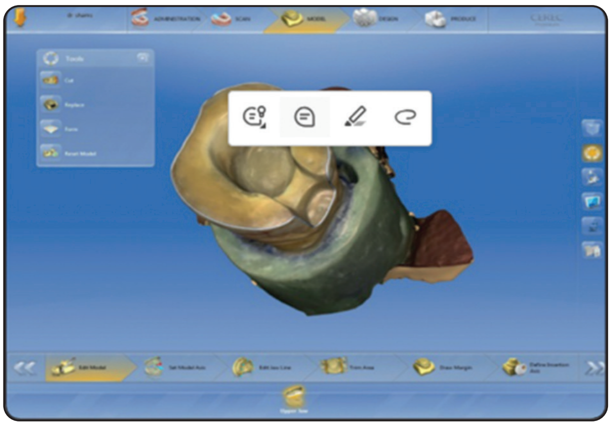

Fig. (2): virtual model to tooth drawing margin

Fig. (3): virtual endocrown

Cementation of endocrowns:

The fitting surfaces of the endocrowns were subjected to ultrasonic cleaning for 3 minutes, followed by rinsing and drying. The specimens were subsequently etched with hydrofluoric acid (90 seconds for IPS e.max CAD, 60 seconds for Grandio CAD), washed, and dried. A silane coupling agent was utilized and allowed to dry for 30 seconds. The dental surfaces were treated with 37% phosphoric acid, washed, and dried, after which a bonding agent was applied and light-cured for 20 seconds. Dual-cured resin cement (Breeze™) was employed for the cementation process. Subsequent to mixing, the endocrowns were cemented, subjected to a 1 kg load for 5 minutes, temporarily light-cured, excess cement was eliminated, and final curing was performed for 20 seconds. Specimens were preserved in distilled water at 37°C for 24 hours.

Thermocycling procedure:

To duplicate clinical services All specimens were subjected to 5000 cycles of thermocycling in a water bath at temperatures ranging from 5 to 55 degrees Celsius, utilizing a standard thermocycling equipment (Thermocycler, Robota, Alexandria, Egypt) for 30 seconds each cycle, with a 5-second transition interval between the two baths. This study used a cycle duration equivalent to two years of clinical treatment, in accordance with ISO/TS 11405 established by the International Organization for Standardization.

Fracture resistance testing:

These tests were performed using Bluehill Lite Software from Instron®.

Test procedure

Each sample was separately affixed to a computer-controlled materials testing apparatus (Model 3345; Instron Industrial Products, Norwood, MA, USA) equipped with a 5 kN load cell, and data were captured using software (Bluehill Lite Software, Instron®). Samples were affixed to the lowest fixed compartment of the testing apparatus by tightening screws. The fracture test was conducted using a compressive load applied occlusally via a metallic rod with a rounded tip (8.6 mm diameter) affixed to the upper movable compartment of the testing machine, which operated at a crosshead speed of 1 mm/min. A tin foil sheet was interposed to ensure uniform stress distribution and to mitigate the transmission of localized force peaks. The failure load was indicated by an audible crack and corroborated by a significant decline in the load-deflection curve recorded using Bluehill Lite Software from Instron® Instruments. The load necessary for fracture was documented in Newtons.

STATISTICAL ANALYSIS

The data were analyzed utilizing SPSS software (version 25, SPSS, Chicago, IL, USA). Descriptive statistics (mean, standard deviation, minimum, maximum) were employed for parametric quantitative data. The Shapiro-Wilk test was employed to evaluate data distribution, while a two-way ANOVA analyzed the effects of material, elevation, and their interactions. The Independent Samples T-test assessed the four groups, whilst one-way ANOVA and post hoc analysis examined the differences among the groups. A substantial threshold of *p < 0.05* was utilized.

RESULTS

All tested subgroups mean fracture resistance values and standard deviation in micrometers (µm) are shown in tab. (1) and (2), as well as in figs. (4) and (5).

Without marginal elevation, significant differences (p<0.001) were found between Grandio (1925.4±186.2) and E-max (3745.1±241.8). With marginal elevation, no significant difference (p=0.448) was observed between Grandio (2735±265.6) and E-max (2601.8±261.7).

Both materials showed significant differences (p≤0.001) between samples with and without marginal elevation. Grandio showed higher resistance with marginal elevation (2735±265.6 vs 1925.4±186.2), while E-max showed lower resistance with marginal elevation (2601.8±261.7 vs 3745.1±241.8).

TABLE (1) Comparison of fracture resistance with and without marginal elevation between Grandio and E-max materials.

	Marginal elevation	Material		P value
		Grandio	E-max	
		N=5	N=5	
Fracture resistance	*Without*	1925.4±186.2	3745.1±241.8	*<0.001**
	With	2735±265.6	2601.8±261.7	*0.448*

Independent Samples T test for quantitative data between the two groups ****: Significant level at P value < 0.05***

TABLE (2) Comparison of fracture resistance at different materials between samples with and without marginal elevation

	Material	Marginal elevation		P value
		Without	With	
		N=5	N=5	
Fracture resistance	*Grandio*	1925.4±186.2	2735±265.6	*0.001**
	E-max	3745.1±241.8	2601.8±261.7	*<0.001**

Independent Samples T test for quantitative data between the two groups ****: Significant level at P value < 0.05***

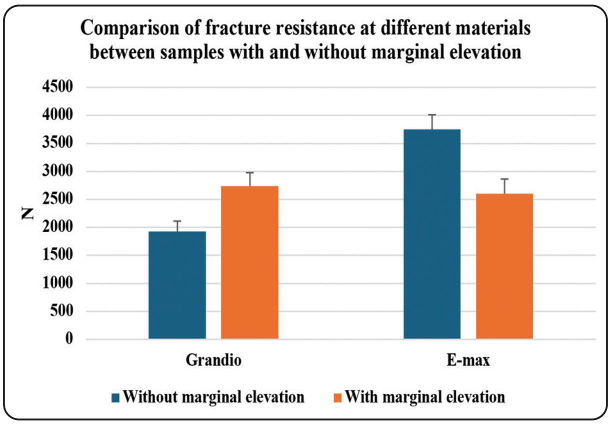

Fig. (4) Comparison of fracture resistance at different materials between samples with and without marginal elevation.

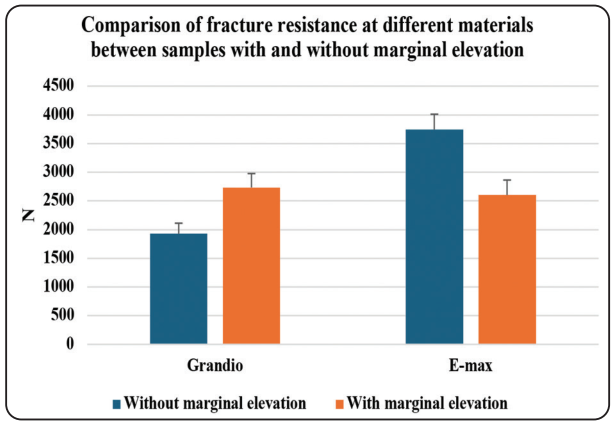

Fig. (5) Comparison of fracture resistance at different materials between samples with and without marginal elevation

DISCUSSION

Choosing a suitable final coronal restoration for endodontically treated teeth continues to pose a considerable problem in routine clinical practice.[11,12] The enduring success of these teeth is predominantly contingent upon the quality of the coronal restoration, which must restore functionality, safeguard the residual tooth structure, and maintain superior marginal integrity.[13]

Proper tooth preparation for endocrowns is crucial and must conform to established norms. A consistent height decrease of 2 mm is required, and although a butt joint margin of 1–1.2 mm is ideal, it is not necessarily essential. Cervical margins should be positioned as supragingivally as feasible. An occlusal divergence of 5–7° is essential to provide continuity between the coronal pulp chamber and the endodontic access cavity. [14]

Proximal carious lesions in highly compromised teeth predominantly manifest at the subgingival region. In these instances, it is advisable to raise the cervical margin using an appropriate direct composite repair. The elevation of the proximal box improves the visibility and accessibility to the cervical border, hence enabling impression taking and enhancing the cementation process, contingent upon adherence to the protocols outlined by Magne et al.[15,16]

Advancements in adhesive dentistry, CAD-CAM technology, and ceramic materials have resulted in the creation of new dental restoration systems, such as the endocrown restoration. This method reduces the likelihood of failure linked to intracanal post preparation.[17,18]

Fracture resistance and marginal adaptability are essential determinants for enduring effectiveness of coronal repair. The restrictions and disadvantages of several restorative materials underscore the necessity for alternatives that provide enhanced results.

Nonetheless, alterations to the preparation may be implemented for aesthetic, biomechanical, or material considerations, such as decreasing the axial height of the cusps below standard recommendations. The scientifically verified enhancement of fracture resistance with the use of a ferrule design defies the ideals of minimally invasive dentistry.

Diverse materials employed for endocrowns comprise lithium disilicate glass-ceramic, zirconia, zirconia-reinforced lithium silicate glass-ceramic, and resin composites.[19] The choice of material plays a crucial role in determining the mechanical properties and performance of endocrowns. Lithium disilicate glass-ceramic is often favored due to its excellent mechanical strength, bonding capability, and aesthetic results. Studies have demonstrated that it offers superior fracture resistance compared to other materials, particularly under lateral loading.[20,21]

The vivo investigation comprised twelve individuals with endodontically treated first mandibular teeth. Marginal elevation was implemented in six instances, whereas the remaining six were subjected to treatment without marginal elevation. The endocrowns were fabricated utilizing two distinct CAD/CAM technologies.

This in vitro study standardizes all methods across samples, enabling a more exact examination of the variable components under consideration. This design is essential for collecting useful data that might enhance restoration operations.[22]

While the utilization of genuine teeth in the study may have brought variability owing to standardization problems, the presence of enamel and dentin offers a more precise reflection of the clinical environment.[23] Natural teeth exhibit advantages over metallic and resin-based materials for biomechanics and adhesion.[23] Consequently, the present study employed freshly extracted human teeth to emulate the clinical conditions pertinent to enamel and dentin bonding, strength, pulp chamber morphology, and the elastic modulus of hard dental tissue, thus simulating the force distribution on the root segment of the tooth structure. Human teeth were selected over metal, plastic, or bovine replicas because to their ability to recreate the bonding characteristics, modulus of elasticity, thermal conductivity, and strength observed in clinical scenarios.[24] The dimensions of all teeth chosen for this investigation were consistent, and statistical analysis was performed to exclude any samples that deviated from a comparable measurement range.[25] The chosen samples were preserved in a 0.1% thymol solution to avert brittleness and desiccation. Teeth.[26] Teeth exhibiting caries, fractures, or prior restorations were omitted from the research. This methodology aligns with the research conducted by Elsharkawy et al. (2021).[27]

All specimens were produced by a single operator adhering to a systematic, predetermined preparation technique to guarantee consistency in measurement and design.[2] The specimens were sectioned perpendicular to the long axis to provide a typical butt-joint preparation 2 mm coronal to the cementoenamel junction, replicating the compromised state of severely damaged endodontically treated teeth. This length is also appropriate for ensuring frictional retention by contact between the dentinal wall of the pulp chamber and the restoration (macro-mechanical retention).[28]

Following endodontic treatment, crowns were fabricated utilizing a CNC machine to guarantee uniform axial wall thickness and cavity depth. CAD/CAM technology was employed to standardize the restoration thickness and shape, as well as to ascertain the region of load application during testing. All specimens underwent endodontic treatment, after which crowns were fabricated using a CNC machine to provide uniform axial wall thickness and cavity depth, in accordance with the guidelines established by Hayes et al. (2017).[29] The authors emphasized that endocrowns featuring profound pulpal extensions were more susceptible to irreversible fractures.

The research selected CAD/CAM technology to standardize the thickness and shape of restorations, with the objective of identifying the load application area during testing. This methodology aligned with the research conducted by El-Damanhoury et al., 2015.[30]

To guarantee excellent adhesion and durability, the endocrowns were immersed in distilled water utilizing a digital ultrasonic cleaner. The teeth were polished with pumice paste, washed, and dried. The endocrown fitting surfaces were etched using hydrofluoric acid, thereafter treated with a silane coupling agent. The dental surfaces were subjected to phosphoric acid treatment. Dual-cure adhesive resin cement was employed for cementation, involving early light curing to eliminate surplus resin and subsequent light curing to guarantee complete polymerization. This approach adhered to the adhesive cementation protocols outlined by Albelasy et al,[31] and was consistent with the systematic review conducted by Makaronidis et al..[32]

The proximal box was increased utilizing IPS Empress, a nanocomposite characterized by superior physical and mechanical capabilities attributed to its enhanced nano-filler particle content.

Endocrowns were machined to uniform occlusal morphology and height to guarantee constant dimensions.[33]

Thermocycling with a water bath was conducted post-cementation, since it is a recognized technique for simulating aging in the oral environment, replicating variations in humidity and temperature.[34]

The fracture resistance test utilized a 6mm steel sphere, optimal for molars, since it simulates the interaction between functional and non-functional cusps, accurately reflecting the clinical loading of occlusion.[35 ,36]

In the current investigation, concerning the building material without marginal elevation, the E-max groups fabricated from IPS E-max blocks demonstrated considerably greater fracture resistance compared to the Grandio groups composed of hybrid ceramic blocks. This conclusion aligns with the research conducted by Sagsoz and Yanikoglu.[37] and Ali et al. (2020).[33] Grandio exhibited greater resistance with slight elevation, but E-max shown reduced resistance with slight elevation. Conversely, concerning marginal elevation, both materials demonstrated that the groups with marginal elevation displayed superior fracture resistance compared to the groups without elevation,[38] The fracture resistance analysis conducted during the measurement methods indicated a statistically significant influence of the material type on fracture resistance, resulting in the rejection of the initial null hypothesis.

These results are consistent with the findings of Ali et al. (2020.[33] Furthermore, the fracture resistance of all groups fell below clinically acceptable thresholds, likely due to the intrinsically superior mechanical characteristics of the ceramic materials evaluated. Both e.max and Grandio demonstrate superior

Flexural strength exceeds the maximal biting forces, which is 725 N for a posterior single molar tooth.[39,40]

Rigid glass-ceramic materials, such as lithium disilicate (LD), possess a distinct modulus of elasticity, potentially causing stress concentrations in localized regions and leading to catastrophic failure mechanisms.[30] The results of this work correspond with a comprehensive review that evaluated the fracture resistance of LD and resin nanoceramic endocrowns under load, concluding that resin nanoceramic endocrowns demonstrate fracture resistance values akin to those of LD endocrowns.[41]

Besides the design of the endocrown preparation, the distribution of occlusal pressures is crucial. The forces acting on the endocrown are applied as compression at the butt-joint, creating a stable, parallel surface to the occlusal plane, hence improving resistance to compressive stress. Conversely, the load on the proximal box is transmitted as shear force, which is mitigated by the small axial walls of the proximal box. Collectively, these elements enhance the restoration's superior fracture resistance. Furthermore, beyond the intrinsic mechanical capabilities of lithium disilicate ceramics, the composition of IPS E-max exhibits a dense interlocking arrangement of elongated disilicate crystals, which aids in preventing crack propagationn.[42]

Numerous studies have demonstrated comparable fracture resistance in teeth treated with composite materials relative to undamaged, unrestored teeth. Consequently, mesial marginal elevation utilizing adhesive materials may operate comparably to intact dental structure underneath the ceramic endocrown edge, facilitating advantageous stress distribution.[43] Zamboni et al. (2014),[9] proposed that employing deep marginal elevation diminishes cuspal deflection, hence fortifying the cusps and enhancing fracture resistance. Consequently, the null hypotheses were dismissed

Our findings corroborate prior research indicating that marginal elevation positively affects the fracture resistance of diverse restorations. Illgenstein et al. (2015),[44] revealed that deep marginal elevation improves the fracture resistance of endodontically treated teeth replaced with CAD/CAM ceramic inlays, particularly under high loads or eccentric stresses.

The findings indicated no statistically significant difference between restorations including proximal box elevation and those lacking it. This can be ascribed to the resin elevation of the proximal box, which functions as a stress alleviator during the loading of the restoration by dissipating a portion of the stress. Moreover, composite resin possesses mechanical qualities akin to those of human dentin, therefore mitigating the pressures imposed on the remaining tooth structure[44]

In the research by Mohamed et al. (2024),[45] a notable difference in fracture resistance was identified between the two groups. The Emax CAD endocrowns exhibited much greater fracture resistance compared to the Tessera (hybrid ceramic) endocrowns. This disparity can be ascribed to the differences in mechanical characteristics, chemical composition, and microstructure of the two materials. Emax CAD, recognized for its impressive flexural strength of 360 MPa and fracture toughness of 2.25 MPa m½, likely enhances its exceptional fracture resistance. The material's superior adhesive characteristics and resistance to dislodgment, augmented by its acid-etching process, further bolster its efficacy in load-bearing applications. These findings underscore the need of comprehending material characteristics when choosing CAD/CAM materials for clinical applications, particularly in contexts where fracture resistance is crucial for long-term success.[46]

The study determined that the fracture strength of Emax CAD anterior endocrowns had a superior mean fracture strength in comparison to Tessera (hybrid ceramic) endocrowns. This conclusion aligns with the 2012 [47] study, by Sherif and El-Dwakhly, which assessed the fatigue resistance of three-unit CAD/CAM restorations. Teeth reinforced with restorations possessing an elastic modulus akin to dentin, such as Empress-CAD, exhibited superior stress distribution across the restorative structure, resulting in a failure mode more conducive to repair.

El Ghoul (2020)[48] indicated that the marginal and internal inconsistencies fluctuated according on the materials employed. The ceramic-based groups demonstrated reduced gaps relative to the resin-based groups.

Salem et al. (2024),[49] conducted a comparative analysis of marginal adaptation between lithium disilicate (Emax) and hybrid nano-ceramic (Grandio) CAD/CAM endocrowns. Their study evaluated marginal adaptation, retention, and fracture resistance, indicating that all restorations in both groups achieved Alpha scores at baseline and after 12, 24, and 36 months. The consistency of data indicates that both Emax and hybrid nano-ceramic materials offer stable marginal adaptation and fracture resistance over prolonged durations. Nonetheless, despite these resemblances, the differences in material qualities highlight the necessity of choosing materials according to particular clinical requirements and mechanical specifications.

The study by Sağlam et al. (2020) assessed the marginal fit and fracture strength of feldspathic and Polymer-Infiltrated Ceramic Network (PICN) CAD/CAM endocrowns for maxillary premolars. They found that while both types of CAD/CAM-fabricated endocrowns exhibited adequate marginal adaptation, the PICN endocrowns demonstrated superior fracture resistance compared to the feldspathic ceramic endocrowns. This supports our findings of material-specific differences in fracture resistance. Furthermore, ElHamid et al.[50] evaluated the fracture resistance and marginal adaptation of endocrowns using two distinct heat-press ceramic materials. They found that for marginal adaptation assessment, both materials showed no significant difference, with their values falling within the clinically acceptable range. This corroborates our own observations that the marginal discrepancies between different materials were within clinically acceptable limits, highlighting the overall effectiveness of the restoration materials in terms of both marginal fit and fracture resistance.

Ali and Moukarab (2020)[33] investigated the influence of deep marginal elevation on the marginal adaption and fracture resistance of endodontically treated teeth repaired with endocrowns fabricated from two distinct CAD/CAM ceramics in an in vitro investigation. Their findings demonstrated that IPS Emax CAD shown enhanced fracture resistance relative to Vita Enamic (hybrid composite blocks consist of composite resin integrated with ceramic filler particles).

Additionally,, Dejak & Młotkowski (2018)[51] evaluated the longevity of anterior teeth treated using ceramic endocrowns compared to custom-fabricated post and core systems. Their research revealed that endocrowns composed of lithium disilicate ceramic had significant fracture resistance. So the null hypotheses were rejected.

CONCLUSION

Based on the results gained from this study, we can conclude that: E-max without marginal elevation is superior fracture resistance, followed by Grandio with marginal elevation, followed by E-max with marginal elevation and the least fractured resistance is Grandio without marginal elevation.

Limitation

As the search for the optimum restoration for endodontically treated teeth is continuous, further studies are needed to investigate the behavior of similar treatments for teeth in other positions in the dental arches. Furthermore, additional clinical studies are needed to be able to directly correlate the results of this study to the actual clinical conditions.

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