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Impact of Preparation Designs and Distinct restorations on Marginal Precession, and Fracture Resistance of CAD/CAM Fabricated Endocrowns in Pulpally Treated Deciduous Molars

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ABSTRACT

Aim: This study aimed to evaluate the impact of preparation designs and distinct restorations on marginal Precession, and fracture resistance of CAD/CAM fabricated endocrowns in pulpally treated Deciduous molars. **Subjects and Methods:** in-vitro experimental study involved 60 primary molar teeth, which underwent pulpotomy and standardized endo crown preparation. The utilized teeth were split into 6 groups by random method (10 teeth/group) depending on the restorative material used G 1: sound primary molars, G 2: pulpotomized primary molars with no coronal restoration, G 3: restored with Beautifil Flow Plus X, G 4: restored with CAD/CAM Milled Poly-methyl methacrylate., Group 5: restored using lithium disilicate endocrown. G 6: restored by CAD/CAM Milled dental zirconia block. All samples were exposed to fracture testing using a universal testing machine with compressive power applied. **Results**: in regard to Fracture resistance, half depth: Zirconia had the greatest mean value, then Composite, E. max, and the PMMA group. All groups were statistically significant. Complete depth: Zirconia had the greatest mean value, which was followed by the PMMA group, Composite, and E. max. One-third of the samples in the zirconia group displayed a good fracture, while 33.3% of the samples in the E-max group revealed a fractured tooth and restoration. **Conclusion**: Within the parameters of this investigation, our work implies that teeth treated with a pulpotomy may, therefore, be restored using endocrowns. The zirconia showed higher fracture resistance than composite, PMMA and lithium disilicate endocrowns. Marginal gap is higher in PMMA than other material.

KEYWORDS

Endocrowns, pulpotomized primary molars, fracture resistance, CAD-CAM zirconia block, Lithium disilicate.

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INTRODUCTION

The restoration and rehabilitation of teeth that have received endodontic therapy has long presented a biological and biomechanical challenge in the field of remediated dentistry, especially for dentists who treat children [1,2]. The main factor reducing tooth stiffness and fracture is the degradation of the structure drawn on by cavities, trauma, and careful cavity preparation [3]. Additionally, the likelihood of crown breakage and microleakage surrounding endodontically treated dental repair margins is increased by this loss of structural integrity [4,5].

Numerous full coverage restoration methods, each with advantages and disadvantages, have been employed for deciduous teeth. Cosmetic solutions are increasingly in demand in pediatric dentistry these days, mostly for psychological reasons to please patients and their parents. Because of this, several gorgeous prefabricated crowns have gained popularity for deciduous teeth and are an excellent alternative to stainless steel crowns (SSC) [6-8]. Though, making an impression on a child is really challenging and requires their help [9].

Endocrown is an alternative therapeutic option for posterior teeth that have undergone endodontic treatment [2]. This is made possible by recent developments and advances in composite materials and adhesive methods [1]. Furthermore, because the CAD/CAM approach is so widely available in dental labs and clinics, indirect restorations are increasingly being chosen over conventional treatment modalities. With the right level of accuracy, quality, and aesthetics, these technologies can easily create milling restorations [10]. The endocrown is built as a single unit core known as a monobloc[3,4]. Adhesive bonding provides stability to the monobloc core that is positioned within the pulp chamber. Endocrown is recommended for patients with limitted intermaxillary space or brief clinical crown[11]. Nevertheless, this restorative option should not be used if bonding is not possible or if the tooth has a pulp chamber that is shorter than 3 mm deep or cervical margins that are lower than 2 mm thin [12].

Mineral ceramic or composite ceramic [13] can be used to create an endocrown in primary molars, however this innovative restorative technique has not been fully studied. The aims of the current in vitro work were directed to estimate the fracture resistance of human molars that had undergone pulpotomy and had been prepared using two different coronal preparation designs. The teeth would ultimately be repaired with an endocrown that had been machined using either a ceramic block, composite, or acrylic resin.

MATERIALS AND METHODS

The design of the investigation was based on an in vitro experimental paradigm. Ethical committee approval (no. 890/2024)

Calculating the sample size

The work of El Makawi and Khattab[14] and Yehia et al.[15] as well as the G power statistical power calculation software (version 3.1.9.4) for determination of sample size [16]can be used to determine that a total size of sample of 60, with 10 in each group, will be adequate to identify a significant effect size (f) = 0.505, with a real power (1-β error) of 0.8 (80%) and a level of significance (α error) of 0.05 (5%) for two-sided hypothesis test.

Selection of Teeth: To complete this experiment, sixty primary molars were gathered and extracted.

The teeth were then chosen based on the subsequent inclusion criteria: The half of the root was still present at least, the floor was intact, the tooth’s axial walls were intact in at least three places, and there was enamel present on the crown borders. Using a hand scaler, the teeth were extracted from the soft tissue deposits. The teeth were then inspected, and any molars showing fractures or breaks were excluded [17] Following that, they were stocked at room temperature in a sodium chloride solution (NaCl 0.9%) solution until they were used. They were then disinfected with 10% thymol.

Using flowable glass ionomer, six groups were randomized to receive the prepared teeth and treated to create symmetrical pulp chamber floors that were about similar to and two depths below the sectioned molar occlusal table at half and full depth.

After that, the samples were ready for their end form using the same handpiece and diamond bur to get the necessary shapes.

Teeth mounting: to become close to the alveolar bone’s healthy height, The chosen teeth were individually repaired using Acrozoite selfcuring acrylic resin (Acrostone Acrylic Material -ST Cold Cure, EGYPT) in a specifically developed “Teflon” mold, with the CEJ left 2 mm parallel to the acrylic resin and above it.

Grouping of teeth:

Six groups were randomly selected based on factors such as coronal preparation techniques, milling materials for endocrowns, and pulp treatment procedures. Fifty additional teeth had complete pulpotomy, and ten teeth were left intact. Ten of the fifty teeth in the subgroup remained unrestored following polytherapy. Based on the type of coronal preparation and the material utilized, the remaining forty were split into four groups of ten.

After making 1.5 mm depth cuts with a tapered stone (TR-12 Dia Bur Mani), a wheel stone (WR-13 Dia Bur Mani) was placed on top to decrease the occlusal surface. The horizontal configured determines the cervical margin, which is often referred to as the “butt joint” finish line or the “cervical sidewalk” since it is sufficiently flexible to allow clearance from the whole surface. Furthermore, the vertical component was modified by permitting a mere 1.5 mm decrease.

Axial wall preparation: The tapered stone (TR-12 Dia Bur Mani) with an 8-degree angle was used to flare the axial walls to a standard degree of divergence. The vertical component was set so that the stone nearly contacted the Glass Ionomer base, while the horizontal component was left flexible. The interior angles of the edges were rounded and smoothed with the same diamond point. An abrasive rubber tip was then used to polish the inside angles, creating a smooth and polished preparation.

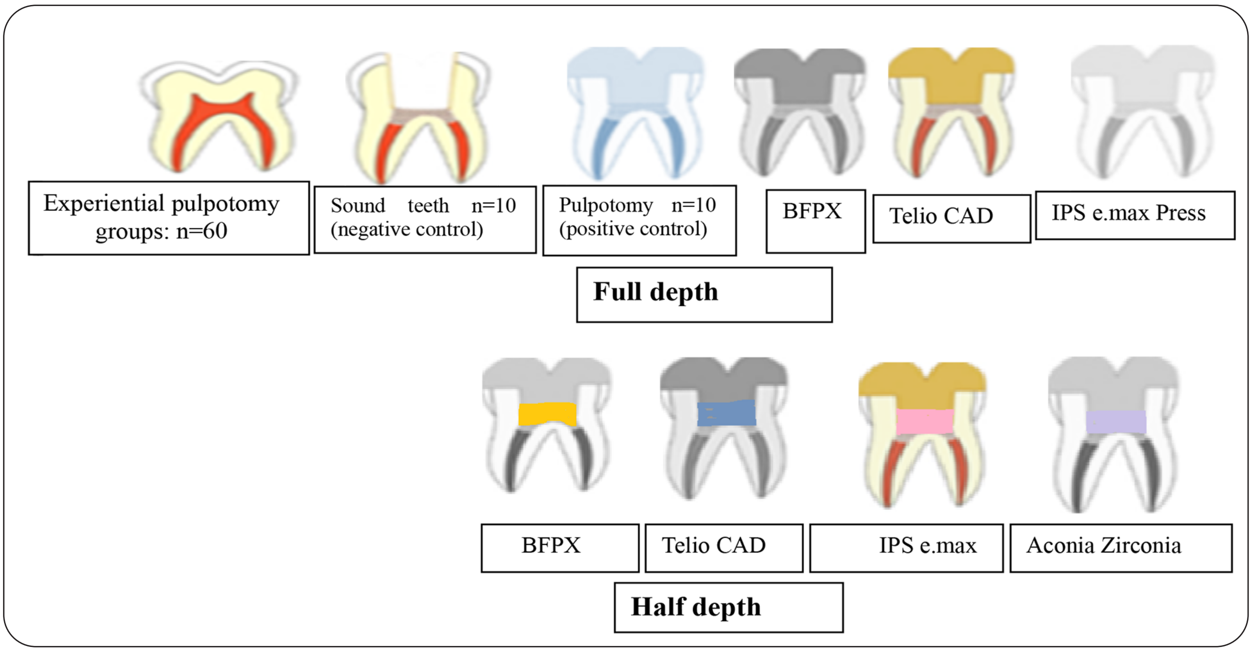

Fig. (1) Study design

Experimental pulpotomy groups:

Group 1: Teeth sound (positive control)

Group 2: pupotomized teeth with no coronal regeneration (negative control)

Group (G3a): pulpotomized primary molars restored with Beautifil Flow Plus X (BFPX)to full depth of pulp chamber.

Group (G3b): Pulpotomized primary molars restored with Beautifil Flow Plus X (BFPX)to half depth of pulp chamber.

Group (G4a): Pulpotomized primary molar restored with CAD/CAM Milled Poly-methyl methacrylate (Telio CAD) to full depth of pulp chamber.

Group (G4b): Pulpotomized primary molar restored with CAD/CAM Milled Poly-methyl methacrylate (Telio CAD) to half depth of pulp chamber.

Group (G5a): Pulpotomized primary molars restored to full pulp chamber depth using lithium disilicate (IPS e.max Press) endocrown.

Group (G5b): Pulpotomized primary molars restored to half pulp chamber depth using lithium disilicate (IPS e.max Press) endocrown.

Group (G6a): pulpotomized primary molar restored by CAD/CAM Milled dental zirconia block (Aconia Zirconia) to full depth of pulp chamber.

Group (G6b): pulpotomized primary molar restored by CAD/CAM Milled dental zirconia block (Aconia Zirconia) to half depth of pulp chamber.

Study Criteria

The main criteria of the study was the fracture force resistance showed in Newtons. The 2nd criterion was the fracture type [18]. (i) A fracture that was above the cementoenamel junction was considered favorable ; (ii) a fracture that was under the cementoenamel junction and continued up to the root was considered disastrous.the third marginal adaptation criterion.

The pulpotomy procedure was done as follows:

The access cavity was created utilizing a cylindrical conical diamond bur with an 8° occlusal convergence in order to make the pulp chamber and cavity continuous. After that, the pulp chamber was smoothed with minimal pressure utilizing an occlusal butt joint. After using metapex to obturate the canal, a coating of GIC was applied to the pulpal floor to improve adhesion and to seal and protect the canal orifices [19]. The cavity depth was then determined.

Fig. (2) A) showing occlusal depth cuts for occlusal reduction of endocrown preparation, B) showing mounted wheel stone on conventional-speed straight hand-piece attached to the milling machine was reducing occlusal surface with coolant to produce a flat cervical sidewalk, C) showing a mounted tapered stone of 8-degree angle during flaring of axial wall for the axial preparation of endocrown, D) showing final tooth preparation for endocrown restoration with "cervical sidewalk" after smoothening and polishing the walls, E) CAD CAM fabricated endocrown of half depth, F) CAD CAM fabricated endocrown of full depth

Restoration fabrication

All the teeth in the CAD/CAM groups were first covered with a Telescan light-reflecting powder from Vita Zahnfabrik, Germany, in order to create an optical impression of the sample. A CEREC In Lab scanner (Germany: InEos X5 Sirona) was used to scan every tooth in order to create optical impressions that were then used to create 3D virtual models. The CEREC AC system (Sirona Dental Systems, GmbH, Bensheim, Germany) was utilized to prepare the restoration. Following the selection of the restoration type on the program, the virtual die was inspected and verified. Here, the software prevents any undesired undercuts, allowing the restoration to be generated with an altered insertion path. Subsequently, during the design stage, the model was used to showcase the suggested endocrown design and make any necessary modifications. The chosen block was ground in the MC XL unit's milling chamber once the necessary grinding tools had been obtained and the milling order had been initiated. As directed by the manufacturer, finishing and polishing procedures came after the milling process.

Regarding the indirect composite group restorations, the cavity that had been constructed was dried, and the interocclusal space had been thoroughly assessed. We looked for undercuts and abnormalities in the pulp chamber. After adding separating medium to the chamber, injectable BEAUTIFIL Flow Plus X flowable composite buildup was added. Light cure composite resin was also used to create the sprue, making it simple to remove the crown from the mold. After sprue attachment and subsequent construction, the first layer of composite was adjusted to the preparation's base using a fine-tipped explorer to help tease the material into small regions. After being polymerized, the composite resin was adjusted to the cuspal form. After the restoration was removed and examined, diamond grits of fine and extremely fine for wet grinding was used to complete the restorations, which were then polished.

The endocrown was tried in, and the marginal adaptations and occlusion were examined and confirmed (Fig. 3).

Endocrowns Cementation:

The manufacturer's instructions were followed while treating the endocrowns fitting surfaces prior to cementation. The endocrown groups three and four fitting surfaces were subjected to sandblasting using 50 µm Al2 O3 powder (0.15 MPa/1.5 bar pressure, with a 10mm spacing).

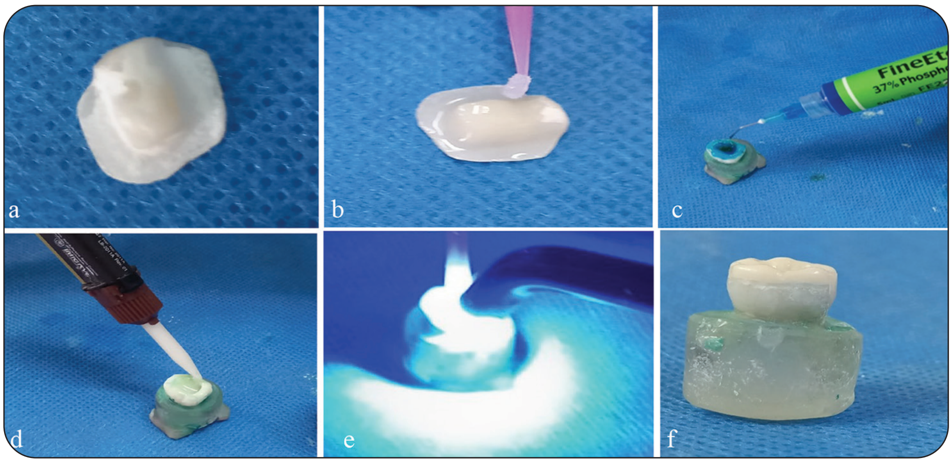

Fig. (3) Showing steps of cementation of endocrown A: etching of intaglio of endocrown with 9.5% HF acid for 20 seconds then rinsed thoroughly for 60 seconds B: Porcelain Silane(Ultradent Products USA) was then applied by micro brush on the etched intaglio, C: enamel was selectively etched by 37% Phosphoric acid for 20 sec, D: Then the Self-adhesive automix dual-cure resin cement (IMICRYL dental. TURKEY), E: Polyerization F: Endocrown after cementation.

Endocrown fitting surfaces of the fifth and sixth groups were etched for 20 seconds using 37% Any-etch (Mediclus – Korea). After that, a silane coupling agent (Bisco, USA) was applied, and the surfaces were permitted to dry for 60 seconds.

After applying an adhesive (All Bond Universal, Bisco, USA), the surfaces were once more given a 60-second drying period.

Using an aqueous pumice suspension and a low-speed cleaning toothbrush in a low-speed handpiece (Dentsply, York, USA), all the samples (teeth) were cleaned for 20 seconds. The samples were dried with oil-free air after being cleaned with an air-water spray for 20 seconds. All samples were looted using NOVA RESIN CEMENT IMICRYL, a dual cure self-adhesive resin cement type, while static finger pressure was applied. Following the removal of excess cement, a 20-second light cure was applied to each side. The cervical vertical marginal gaps were measured after being cemented and kept in distilled water for a day.

Testing of fracture resistance:

The Instron Bluehill Lite software was used to conduct these tests.

For every sample, a computer-controlled materials testing device (Model 3345; Instron Industrial Products, Norwood, MA, USA) equipped with a 5 kN loadcell was utilized. Instron® Bluehill Lite Software was utilized to record the data. Samples were securely fastened to the lowest fixed compartment of the testing equipment using tightened screws. To attain a uniform distribution of stress and reduce the propagation of local power peaks, a steal rod with a spherical tip (8.6 mm in diameter) was used for the fracture test. The rod was fixed to the upper moving part of the testing apparatus. The rod moved through a sheet of tin foil at a crosshead speed of 1 mm/min.

The load at failure was detected by an audible crack, and a steep drop was shown in the load-deflection curve captured by computer software (Bluehill Lite Software Instron® Instruments). Newton noted the load at which a fracture would occur (Figs. 4, 5).

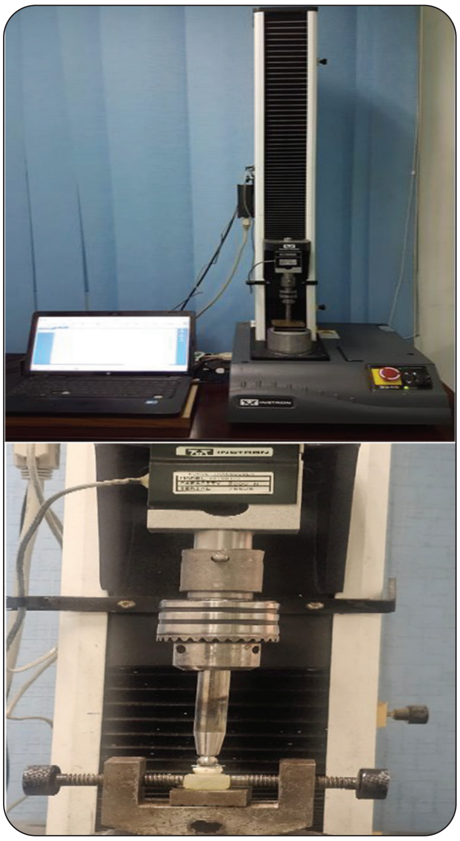

Fig. (4) Showing fracture test done by compressive mode of load applied occlusally using a metallic rod with spherical tip (8.6 mm diameter) using a universal testing machine

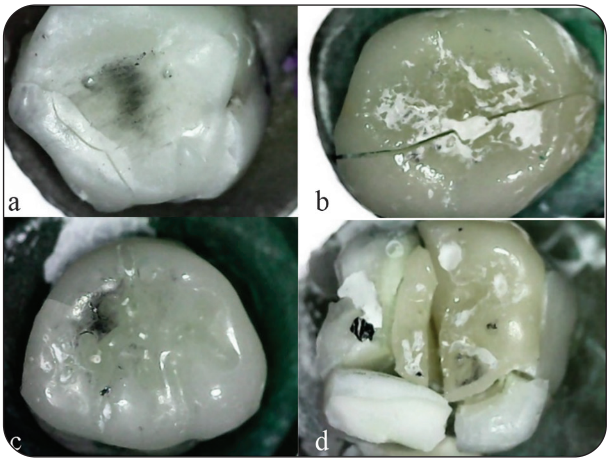

Fig. (5) Showing Failure mode a) emax fracture restoration only. b) Composite fracture restoration and tooth. c) PMMA fracture restoration. d) Zr fracture restoration and tooth

Marginal gap distance:

Using a USB electronic microscope with an integrated camera, each samples was captured on camera.

Technique: This image acquisition system was used to capture the photographs.

1. A vertically positioned digital camera (U500x Digital Microscope, Guangdong, China) 2.5 cm away from the samples, with a resolution of 3 Mega Pixels. The angle formed by the lens's axis and the light source is roughly 90 degrees.
2. Eight LED lamps, each with a control wheel for adjustment, were used to create illumination with a color index of about 95%. The photographs were captured at their highest resolution and fixed at 40X magnification, then linked to a suitable desktop PC. A resolution of 1280 × 1024 pixels was used to record each image.
3. The gap width was measured and assessed using a computerized image analysis system (Image J 1.43U, National Institute of Health, USA). Boundaries, dimensions, frames, and pixel-based measurable attributes are all provided by the Image J software. Consequently, system calibration was carried out to translate the pixels into accurate readings in the actual setting.
4. To calibrate, a scale produced by the Image J program was compared to an object of known size, in this case a ruler. For every sample, shots of the edges were obtained on all surfaces.
5. Following that, morphometric measurements (equidistant landmarks throughout the circumference for each surface) were made for every image. Every measurement was made three times at each location. After then, the information was gathered and tabulated.

Analytical statistics

The standard deviation (SD), confidence intervals, and meaning of the data were shown. Utilizing the Shapiro-Wilk and Kolmogorov-Smirnov tests of normalcy, the data was considered normal. The independent t-test was employed for subgroup comparisons because the data were parametric and distributed normally, and the ANOVA test was used for intergroup comparisons, proceeded by the Bonferroni post hoc test.

A significant results of $p \leq 0.05$ was established. A commercially accessible Windows software package (SPSS 20-Statistical Package for Scientific Studies, SPSS, Inc., Chicago, IL, USA) was utilized to perform the statistical analysis.

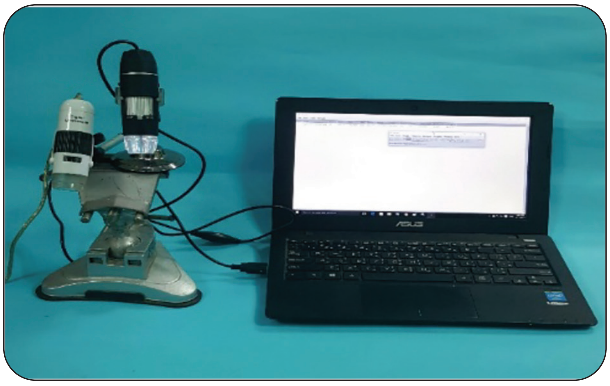

Fig. (6) Showing failure mode done by USB Digital microscope with a built-in camera. Digital camera (***U500x Digital Microscope***)

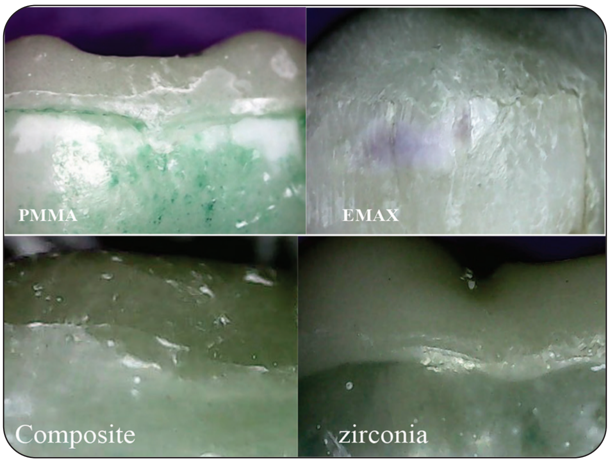

Fig. (7) Showing sample photographed using USB Digital microscope with a built-in camera.

RESULTS

I-Marginal gap (μm)

a- Comparison between groups

Results are summarized in **Table (1) and Fig. (8)**

Half depth: PMMA group recorded the greatest mean value(61.22±1.54) μm., This result was substantially higher than zirconia(42.21±2.11) μm., E. max (43.16±3.4) μm., and Composite (44.61±3.16) μm., values. PMMA group and the other three groups differed from each other in a statistically significant way (p=0.000). E.max, composite, and zirconia did not significantly differ, according to the post hoc test.

Full depth: The elevated mean value was showed in PMMA group (72.67±3.36), followed by zirconia (51.31±1.11). Significantly lower values were recorded in Composite (42.4±2.29) and E. max (39.3± 2.95). The group differences were statistically significant (p=0.000). E.max and composite did not significantly differ, according to the post hoc test.

b- Comparison between subgroups of the same group

Results are summarized in **Table (1) and Fig. (8)**

E-max: The difference between values recorded in half and full depth was (3.86±2.01) μm.. This difference without statistical significancy (p=0.092)

PMMA: A significantly higher value was recorded in full depth in comparison to half depth (p=0.001), with mean difference (11.46±1.65) μm,,

Composite: The difference between values recorded in half and full depth was (2.21±1.74) μm,,. This without statistical significancy (p=0.241)

Zirconia: A significantly higher value was recorded in full depth in comparison to half depth (p=0.000), with mean difference (9.1±1.07) μm,,

Table (2) *Comparing descriptive statistics (ANOVA) with the marginal gap (μm) among the groups.*

Subgroups	Groups	Mean	Std.Dev.	95% Confidence Interval forMean		Min	Max	p value	P value (overall)
				Lower Bound	Upper Bound				
Half depth	**E.max**	43.16^{d}	3.40	38.94	47.38	40.15	47.36	.000*	.000*
	PMMA	61.22^{b}	1.54	59.31	63.13	59.80	63.84		
	Composite	44.61^{d}	3.16	40.68	48.53	40.10	47.73		
	Zirconia	42.21^{d}	2.11	39.60	44.83	40.21	44.67		
Full depth	**E.max**	39.30^{d}	2.95	35.64	42.96	35.30	43.30	.000*	
	PMMA	72.67^{a}	3.36	68.51	76.84	70.27	77.75		
	Composite	42.40^{d}	2.29	39.56	45.24	39.79	44.87		
	Zirconia	51.31^{C}	1.11	49.93	52.70	50.30	52.72		

*Significance level ≤0.05, *significant*

Post hoc test: indicates that there are no significant differences between groups with the identical superscript letters.

Table (2) *Presents descriptive data and an independent t-test comparison of the marginal gap (µm) between the full depth and half depth within the same group.*

Groups	Subgroups	Mean	Std. Dev	Difference				t	P value
				Mean	Std. Dev	C.I. lower	C.I. upper		
E.max	Half depth	43.16	3.40	3.86	2.01	-.78	8.50	1.92	.092n
	Full depth	39.30	2.95						
PMMA	Half depth	61.22	1.54	-11.46	1.65	-15.57	-7.35	-6.94	.001*
	Full depth	72.67	3.36						
Composite	Half depth	44.61	3.16	2.21	1.74	-1.81	6.23	1.27	.241 n
	Full depth	42.40	2.29						
Zirconia	Half depth	42.21	2.11	-9.10	1.07	-11.70	-6.50	-8.54	.000*
	Full depth	51.31	1.11						

*The significance level is p≤0.05, *significant, ns=non-significant.*

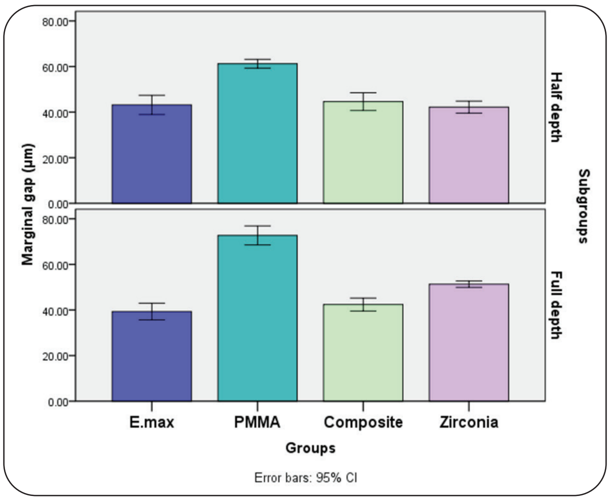

Fig. (8) Bar graph displaying the average value of marginal gap (µm) in full depth and half depth in different groups

II-Fracture resistance

a- Comparison between groups

Results are summarized in **Table (3) and Fig (9)**

Negative control recorded (167.19±24.62 N), while positive control recorded (69.2±13.96 N), and there was a statistically significant difference (p=0.000).

Half depth: The highest mean value was recorded in zirconia (1244.53±113.53N), followed by Composite (691.42±56.56 N), then E. max (642.79± 45.41N), followed by PMMA group (606.48±67.77N). A statistically significant difference was present (p=0.000) between the groups. A post hoc analysis between E.max, PMMA, and composite showed no significant differences.

Full depth: The highest mean value was recorded in zirconia (1270.07±81.67 N), followed by PMMA group (829.78±53.24 N), followed by Composite (654.98±39.95 N), then E. max (617.02± 15.8 N). A statistically significant difference was present (p=0.000) between the groups. A post hoc analysis between E.max and composite.

b- Comparison of the same group's subgroups

Results are summarized in Table (4) and Fig. (9)

E-max: The difference between values recorded in half and full depth was (25.77±21.5). This difference was without statistical significancy (p=0.285).

PMMA: A significantly elevated value was recorded in full depth in comparison to half depth (p=0.000), with the mean difference (223.3±38.54).

Composite: The difference between values recorded in half and full depth was (36.44±30.97). This difference was without statistical significancy (p=0.273).

Zirconia: The difference between values recorded in half and full depth was (25.54±62.54). This difference was without statistical significancy (p=0.694).

Post hoc test: indicates that there are no significant differences between groups with the identical superscript letters.

Table (3) *Descriptive statistics and group-to-group comparison of fracture resistance (Newton) (ANOVA)*

Subgroups	Groups	Mean	Std.Dev.	95% Confidence Interval forMean		Min	Max	p value	P value (overall)
				Lower Bound	Upper Bound				
Control	**Positive Control**	69.2e	13.96	54.20	92.16	55.80	89.10	.000*	.000*
	Negative Control	.167.19d	24.62	138.63	205.59	142.57	191.80		
Half depth	**E.max**	642.79^{C}	45.41	586.41	699.17	594.17	694.50	.000*	
	PMMA	606.48^{C}	-67.77	522.33	690.63	506.50	697.10		
	Composite	691.42^{C}	56.56	621.19	761.65	637.50	783.40		
	Zirconia	1244.53^{a}	113.53	1103.56	1385.49	1144.50	1389.50		
Full depth	**E.max**	617.02^{C}	15.80	597.40	636.64	595.10	634.20	.000*	
	PMMA	829.78^{b}	53.24	763.67	895.89	755.40	889.80		
	Composite	654.98^{C}	39.95	605.38	704.58	609.80	695.00		
	Zirconia	1270.07^{a}	81.67	1168.66	1371.48	1170.10	1370.01		

*Significance level ≤0.05, *significant*

Table (4) *Comparison of fracture resistance (Newton) at full and half depths among the same group, with descriptive statistics (independent t-test)*

Groups	Subgroups	Mean	Std.Dev	Difference				t	p value
				Mean	Std. Dev	C.I. lower	C.I. upper		
E.max	Half depth	642.79	45.41	25.77	21.50	-29.65	81.19	1.20	.285
	Full depth	617.02	15.80						ns
PMMA	Half depth	606.48	67.77	-	38.54	-312.18	-134.4	-5.79	.000*
	Full depth	829.78	53.24	223.3					
Composite	Half depth	691.42	56.56	36.44	30.97	-34.97	107.85	1.18	.273
	Full depth	654.98	39.95						ns
Zirconia	Half depth	1244.53	113.53	-	62.54	-169.77	118.68	-.41	.694
	Full depth	1270.07	81.67	25.54					ns

*The significance level is p<0.05, *significant, ns=non-significant.*

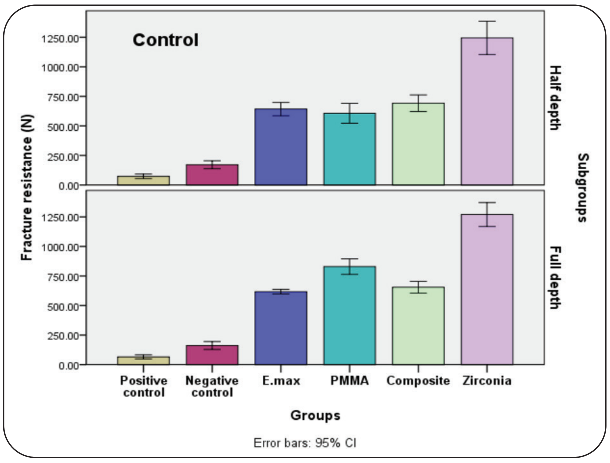

Fig. (9) Bar chart illustrating the mean value of Fracture resistance (Newton) in full depth and half depth in different groups.

III- Fracture mode

Results are summarized in **Table (5) and Fig (10).**

E-max: In full Depth and half depth: 66.7% of samples showed fracture restoration only and 33.3% showed fracture tooth and restoration

PMMA: In full Depth, 33.3% of samples showed fracture restoration only and 66.7% showed fracture tooth and restoration. In half depth, 66.7% of samples showed fracture restoration only and 33.3% showed fracture tooth and restoration. No statistically significant distinction could be found betweenhalf and full depth (p=0.527)

Composite: In full Depth, 33.3% of samples showed fracture restoration only and 66.7% showed fracture tooth and restoration. In half depth, 100% showed fracture tooth and restoration. No statistically significant distinction could be found betweenhalf and full depth (p=0.429)

Zirconia: In full Depth and half depth: 100% showed fracture tooth and restoration.

No statistically significant distinction could be found between any of the subgroups (p=0.648).

Table (5) *Comparison of Fracture mode in different groups and subgroups (chi-square test)*

	E-max		P:MNIA		Composite		Zirconia		P value (all sub-groups)
	Full depth	Half depth	Full depth	Half depth	Full depth	Half depth	Full depth	Half depth	
Restoration only	3 (66.7%)	3 (66.7%)	2 (33.3%)	3 (66.7%)	2 (33.3%)	0	0	0	0.648 ns
Restoration and tooth	2 (33.3%)	2 (33.3%)	3 (66.7%)	2 (33.3%)	3 (66.7%)	5 (100%)	5 (100%)	5 (100%)	
P value (within each group)	1 ns		0.527 ns		0.429 ns		1 ns		

Significance value p≤0.05, ns=non-significant

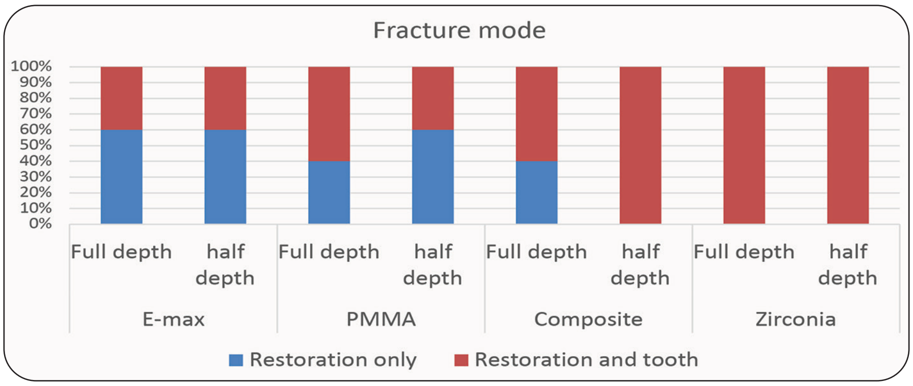

Fig. (10) Bar chart illustrating Fracture mode in full depth and half depth in different groups

DISCUSSION

While pulpotomized primary molars have been effectively restored with stainless steel crowns, juvenile patients and their guardians have been looking for more cosmetic alternatives[20,21].

Indirect restorative materials that are commonly utilized include lithium disilicate glass-ceramic and hybrid resin composite materials. A ceramic made of lithium disilicate has sufficient mechanical strength and aesthetic appeal [22]. As a result, it is currently regarded as among the top materials for repairs done indirectly involving a single unit that is accessible.

Prefabricated Zirconia crowns are an excellent aesthetic substitute, but their widespread use is restricted by several issues, such as the requirement for substantial whole tooth reduction, difficult managing and adjusting, the possibility of wearing down the neighboring teeth, and their comparatively elevated cost [23,24].

Beautifil Flow Plus X is a hybrid composite material that possesses strength, durability, and aesthetic appeal. High flexural strength, low wear resistance, low shrinkage, chameleon effect—aesthetically blending with the natural tooth—and stackability and sculptability ensure that it stays in place.

An endocrown is a conservative restorative technique that maintains the anatomical contour of the pulp chamber's interior preparation while protecting root tissue.

The anchoring mechanism within the pulp chamber and the adoption of an appropriate adhesive method play a vital role in the retention of endocrowns [25]. Therefore, it is thought that using a dual-cured adhesive method is the most effective [26,27]. The restoration of a primary molar that has had endodontic management with this method can be advantageous due to its minimal preparation design, reduced stress concentration, and enhanced aesthetics. Furthermore, it helps lessen the chance of tooth fractures. traditional CEREC endocrowns have a higher stress-bearing capacity than CEREC crowns, as demonstrated by WEIBULL'S ANALYSIS OF BITING, which for normal biting indicates that the failure probability was 2%, 2%, and 2% for traditional crown restorations, inlay, and endocrowns, respectively [28].

In teeth that have cavities prepared or are carious, where the tooth structure has already been compromised, tooth/restoration fractures are most common. Since fracture resistance is a crucial factor in the long-term efficacy of different restorative materials used to restore pulpotomized teeth, it was evaluated in this study [29].

The current study's outcomes indicate there was a statistically significant difference between the groups. A post hoc analysis between E.max, PMMA, and composite showed no significant differences. This result contradicted the findings of Simsek and Derelioglu [17] and Islam et al. [15] who discovered not a difference that is statistically significant in the fracture resistance of endocrowns built using composite using the indirect fabrication technique versus those constructed using CAD/CAM milled Vita Enamic Blocks.

However, it is noteworthy that the results of this study were almost identical to those of earlier research of a similar nature conducted by El Makawi & Khattab [8] and Simsek and Derelioglu [17]. The idea that these restorations would function well in children is supported by the fact that, in both the current study and the previously mentioned studies, all the groups' mean fracture strengths under axial force were higher than the average biting force of a child aged five to ten (375 Newtons) [30]. Axial loading may be interpreted as occlusal forces, in which case the restorative material's thickness and elasticity modulus may be critical to its longevity.

Despite this, the average fracture resistance values were significantly reduced compared to those found by Altier et al. [31] who studied permanent teeth rather than primary molars. This discrepancy may be attributed to inherent differences between primary and permanent teeth, which provides an additional justification for the range of values found in discrete studies.

A prior in vitro study found that, in comparison to composite endocrowns, lithium disilicate ceramic endocrowns displayed a better fracture strength [32] and vice versa, when the materials were analyzed in the current inquiry, lithium disilicate showed a fracture strength that was comparable to the composite group. [18]

however, looked at the fracture resistance of three distinct endocrowns: multiphase resin composite (Lava Ultimate), feldspathic porcelain, and lithium disilicate. In comparison to endocrowns composed of lithium disilicate and feldspathic porcelain, they discovered that the Lava Ultimate resin composite endocrowns had a higher fracture resistance by significant values.

The differences in cementation and test methodology (crosshead speed, kind of load application device, ball diameter, etc.) processes, as well as the differences in the structures of the resin composites utilized, could be the source of the disparities in the results across these investigations.

The fracture modes of every group were also examined in this investigation. According to our findings, the fracture modes observed in E-max endocrowns were 66.7% of samples showed fracture restoration only and 33.3% showed fracture tooth and restoration in E-max: In full Depth and half depth, while in PMMA group, one-third of samples showed fracture restoration only and 66.7% showed catastrophic fracture. In half depth, 66.7% of samples showed a restorable fracture and one-third showed irreparable fracture.

One-third of Composite samples showed fracture restoration only and 66.7% no restorable failures in full Depth. In half depth, 100% showed fracture tooth and restoration, as in full and half depth of the Zirconia group.

Marginal gap between restorations and teeth can cause leakage with its drawbacks including discoloration, dissolution of the luting agent, and pulpal irritation. It can also influence the ability of the restoration to withstand functional loading and consequently its durability.[33]

Results of marginal gap distances for endocrown restorations with the two preparation designs revealed that, Half depth: PMMA group and the other three groups differed from each other in a statistically significant way ($p=0.000$). E.max, composite, and zirconia did not significantly differ, according to the post hoc test.

these results could be due to the low stiffness and elastic property of the resin composite that provide stress distribution that is concentrated around the loading point and not transmitted to the margins, and a superior bond to underlying structure.

Full depth: The elevated mean value was showed in PMMA group followed by zirconia. Significantly lower values were recorded in Composite and E. max. The group differences were statistically significant ($p=0.000$). E.max and composite did not significantly differ, according to the post hoc test.

Many studies stated that the clinically acceptable marginal gap should be less than 120 μm to ensure long-term use of restorations,[34,35,36] marginal gaps of all endocrown materials of the current study present within the clinically accepted range

The results of this study may persuade medical professionals to employ endocrowns whenever the resources necessary to build them are made available, but there are certain drawbacks because certain factors that are present in clinical settings are absent, such as the periodontium’s ability to act as a shock absorber that modifies the effects of inbound stresses and may subsequently improve fracture resistance [32].

CONCLUSIONS

Regardless of the composition of the milling material, and pulpotomy exhibited comparable effects on the strength resistance and fracture type of teeth repaired with endocrowns. All fracture resistance loads obtained were far beyond the maximum masticatory forces, which can withstand the maximum intraoral masticatory forces in the primary molar region. Marginal gaps of all endocrown materials of the current study present within the clinically accepted range Therefore, within the parameters of this investigation, endocrowns may be selected as a restoration for pulpotomy-treated teeth. With the help of CAD/CAM processing, this study offers fresh ideas for treating teeth with inflammatory pulpal disease in a single chairside session.

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تأثير تصميمات التحضير والترميمات المميزة على التقدم الهامشي ومقاومة الكسر لتيجان الأسنان المصنعة بتقنية التصميم بمساعدة الحاسوب والتصنيع بمساعدة الحاسوب في الأضراس اللبنية المعالجة باللب

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الملخص :

الهدف: هدفت هذه الدراسة إلى تقييم تأثير تصميمات التحضير والترميمات المميزة على التقدم الهامشي ومقاومة الكسر لتيجان الأسنان المصنعة بتقنية CAD/CAM في الأضراس اللبنية المعالجة باللب.

المواد والاساليب: شملت الدراسة التجريبية في المختبر 60 ضرسًا لبنيًا. خضعت لبتر اللب وتحضير تاج داخلي موحد. تم تقسيم الأسنان المستخدمة إلى 6 مجموعات بطريقة عشوائية (10 أسنان/مجموعة) اعتمادًا على مادة الترميم المستخدمة: G 1: الأضراس اللبنية السليمة. G 2: الأضراس اللبنية التي تم بتر اللب بدون ترميم تاجي. G 3: الأضراس اللبنية التي تم بتر اللب والتي تم ترميمها باستخدام BEAUTIFIL FLOW PLUS X. G 4: الأضراس اللبنية التي تم بتر اللب والتي تم ترميمها باستخدام بولي ميثيل ميثاكريلات المطحون بتقنية CAD/CAM. المجموعة 5: الأضراس اللبنية التي تم بتر اللب والتي تم ترميمها باستخدام تاج داخلي ثنائي سيليكات الليثيوم. G 6: الأضراس اللبنية التي تم بتر اللب والتي تم ترميمها باستخدام كتلة زركونيا الأسنان المطحونة بتقنية CAD/CAM. خضعت جميع العينات لاختبار الكسر باستخدام جهاز اختبار شامل.

النتائج: أظهرت كلا المجموعتين فرقا غير كبير في PIPD، MBI، MPI وBD. أظهرت مجموعة الأسمنت المحتجزة فقدانًا عظميًا أعلى من المسمار المحتجز (P<0.001) (P=0.002) على التوالي. أظهر IL-1B وMMP-9 تعبيرًا متزايدًا في السائل الشوكي المحيط بالزرعة حول الأسمنت المحتفظ به أكثر من الطرف الاصطناعي المثبت بالمسمار.

الخلاصة: ضمن معايير هذا البحث، يُشير عملنا إلى أنه يمكن ترميم الأسنان المعالجة ببضع اللب باستخدام التيجان الداخلية. أظهرت الزركونيا مقاومة أعلى للكسر مقارنةً بالتيجان الداخلية المصنوعة من المركب، وPMMA، وثنائي سيليكات الليثيوم. الفجوة الهامشية أعلى في PMMA مقارنةً بالمواد الأخرى

الكلمات المفتاحية : تيجان داخلية، الأضراس اللبنية بعد بضع اللب، مقاومة الكسر، كتلة زركونيا بتقنية التصنيع بمساعدة الحاسوب، ثنائي سيليكات الليثيوم