EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 69, 2855:2860, OCTOBER, 2023
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
FIXED PROSTHODONTICS AND DENTAL MATERIALS
Submit Date : 29-04-2023 • Accept Date : 29-07-2023 • Available online: 15-10-2023 • DOI : 10.21608/EDJ.2023.197856.2471

THE EFFECT OF TWO INTRAPULPAL PREPARATION EXTENSION ON FRACTURE RESISTANCE OF ENDO-CROWNS FABRICATED WITH TWO CERAMIC MATERIALS RESTORING PREMOLAR TEETH. (IN VITRO STUDY)

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ABSTRACT

Purpose: This research was conducted to evaluate the effect of two intrapulpal depth with two different materials on fracture resistance of endo-crowns restoring premolars.

Materials & Methods: 28 sound premolars were assigned to two groups (n=14), Group A (2 mm extension into the pulp chamber), Group B (6 mm extension intrapulpally), then each group is subdivided into two subgroups (n=7) according to the type of the material used Subgroup I(Enamic), Subgroup II(Suprinity). All premolars were decoronated to be 3 mm above the CEJ mesiodistally .Samples were split into two groups regarding the type of preparation done. After cementation, fracture resistance test was performed. Data was collected and statistically analyzed.

Results: There was a statistically significant difference between samples regarding different depths of preparation extension were the highest value of fracture resistance was in samples with 6 mm extension depth (1617.43 N) as well as samples regarding the type of the material, where all samples of Vita Suprinity showed higher values of fracture resistance in each depth.

Conclusion: It could be concluded that root canal treated premolars can be restored with endocrowns, moreover, the increase of the preparation depth of the endocrowns lead to restorations which are less prone to fracture

KEYWORDS: Endocrowns, Premolars, Suprinity, Enamic

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INTRODUCTION

Restoring root canaled treated teeth with severe coronal loss has always had an extremely tight protocol, with the manufacture of crowns sustained on metal and/or glass fiber posts and core.[1–4] Firstly, it was thought that this process would provide the best possible solution for strengthening of the remainder of the dental tooth structure[5]. However, it has been acknowledged that the use of intracanal retainers only promoted retention of the fabricated crown. As a result of removing a healthy dental structure to enable the placement of rigid elements devoid of mechanical behaviors similar to those of the tooth[6–9], the remaining tooth could be weakened.

With the development of adhesive dentistry, the urge for applying the usage of posts and cores became much more less. In addition to, the manufacturing of ceramic materials that has high mechanical properties and were capable of being acid etched (such as those reinforced with leucite or lithium disilicate), partnered with the adhesive capacity of adhesive systems and resinous cements, made it applicable to restore posterior teeth, specifically molars, without cores and intraradicular posts which was proved recently that it lead to the weakening of the remaining tooth structure.[10]

Therefore, it is possible now to fully restore posterior teeth with massive coronal damage by onlay and/or overlay restoration and recently, with endocrowns without the use of intraradicular posts and while using the entire extension of the pulp chamber "to increase the surface area of adhesion" as a retentive resource.[10–12]

These dental-crowns would be adhered to the intrapulpal space and on the cavity margins, therefore gaining macro-mechanical retention provided by the pulpal walls, and microretention would be attained with the usage of adhesive cementation. It is a way particularly suggested in cases in which there is massive loss of hard tissues of the crown, interproximal space is limited, and traditional rehabilitation with post and crown is not possible because of inadequate ceramic thickness.[13]

Moreover, because of the absence of enough information about the biomechanical properties of endocrowns and the expectation that this type of restorative material would act equally or superiorly to conventional crowns (because of the potential to be retained in the pulp chamber by micromechanical retention given by the adhesive system and resin cement),

This recent study took place to compare between the fracture resistance of endodontically treated premolars with massive coronal loss, restored by two different preparation extensions into the pulp chamber and two types of ceramic endocrowns Polymer infiltrated Ceramics (Vita Enamic) and Zirconia Reinforced Lithium Disilicate (Vita Suprinity).

MATERIALS AND METHODS

28 extracted (for orthodontic reason) sound, carious free, premolars without any obvious cracks, cleaned and stored at 18ºC in normal saline. Premolar teeth were assigned to two groups (n=14), Group A(2 mm extension into the pulp chamber), Group B(6 mm extension intrapulpally).then each group is subdivided into two subgroups (n=7) according to the type of the material used Subgroup I(Enamic), Subgroup II(Suprinity).

Teeth Preparation

Teeth of similar size and shape were selected by root length where it was 14 mm ±3mm and crown dimensions after the bucco-lingual and mesio-distal widths were measured at the cement-enamel junction (CEJ) in millimeters where the average width of the Buccolingual dimension was 8.5mm and the Mesio-Distal dimension was 6mm and allowing a maximum deviation of 10% from the mean. All

premolars were endodontically treated by the same operator using the same sequence for the purpose of standardization. The pulp space of each tooth was opened following its pulp space morphology using a round carbide high speed bur, endodontically treated with Pro-Taper nickel-titanium (Ni-Ti) rotary files, a 16:1 contra angle handpiece, and ATR Tecnika Vision Motor (DentsplyMaillefer, Ballaigues, Switzerland) according to the manufacturer's instructions and were obturated with gutta-percha by a vertical compaction technique were all these steps were performed by the same operator under the same circumstances for the purpose of standardization.

A Dental surveyor was used to make sure of the upright positioning of teeth in molds which were filled with non-shrink epoxy resin material placing the margin of the epoxy resin below the cemento-enamel junction by 1mm and parallel to the acrylic resin. The crown portion of all premolars were removed to within 3 mm above the CEJ Mesio-Distally. Before the Two different intrapulpal preparation extensions of the endodontically treated premolars were done all the cavities resulting from the endodontic treatment were filled with composite material to ensure the standardization of the two preparation extensions done where they were executed by a Boxford 300VMCi (3D Vertical Machining Centre) using an endmill of 3 mm diameter to ensure that all depths and preparations were standardized Specimens were divided into two groups according to the type of preparation extensions done;

Group A (2 mm extension into the pulp chamber), **Group B (**6 mm extension into the pulp chamber. (Figures1&2)

Endocrown preparation:

Then Each group was subdivided into two sub-groups according to the type of the endocrown ceramic material used, **Subgroup I** (Enamic), **Subgroup II** (Suprinity)

All prepared samples were scanned using a primescan desktop scanner (Dentsply Sirona, USA) . The endo-crowns were designed by a CAD software cerec 5.0.1 (Dentsply Sirona,USA) with different extensions according to the group category but with the same crown design for all the specimens. The final restorations were milled out of CAD/CAM blocks (Enamic) and (Suprinity) according to the sub-group.

All samples were finished and glazed according to the manufacturer's instructions, where Suprinity endocrowns were first crystallized for 26 minutes at 840 celcius temperature then glazed with CZR

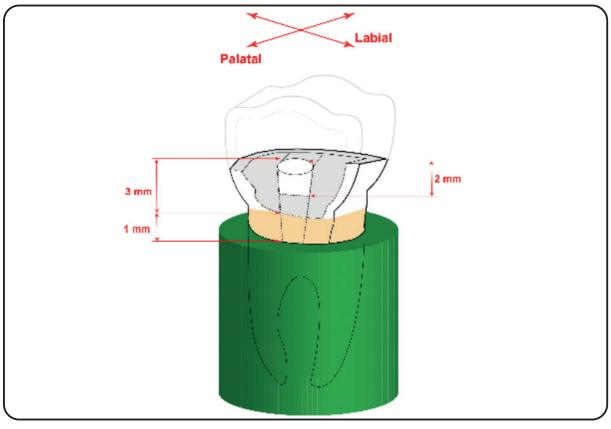

Fig. (1): Diagram showing 2 mm extension inside the pulp chamber

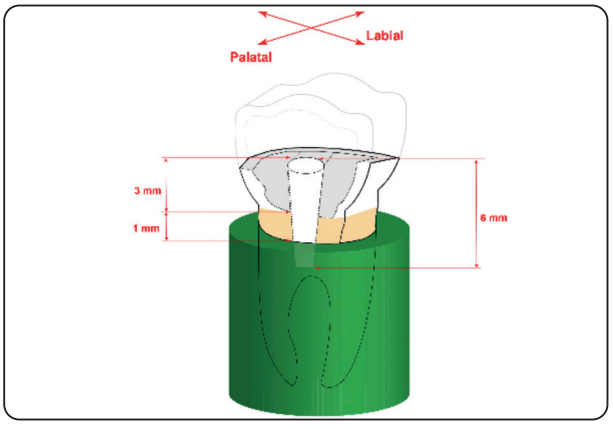

Fig. (2): Diagram showing 6 mm extension inside the pulp chamber

(Kurary, Japan) in ivoclar programat p300. (Ivoclar Vivadent, Liechtenstein) While Enamic was just polished by Vita Enamic polishing kit, The endo-crowns were first treated with Hydrophloric acid (BISCO,USA) (enamic for 60 seconds, Suprinity for 20 seconds) then silane agent (BISCO,USA) was added to both materials for 60 seconds Then cemented to the corresponding samples using dual cured resin cement total cem (Breeze,Pentron,USA) using a loading machine to ensure the escape of all excess material. Finally, all samples were subjected to static loading test using universal testing machine (Vekay ,India) with speed 1mm/min to evaluate the fracture resistance in Newton(N).

Numerical data were explored for normality by checking the data distribution, calculating the mean and median values and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data showed parametric distribution so; it was represented by mean and standard deviation (SD) values. Two-way ANOVA was used to study the effect of different tested variables and their interaction. Comparison of main and simple effects were done utilizing benferroni correction. The significance level was set at $P \leq 0.05$ within all tests. Statistical analysis was performed with IBM*® SPSS**® Statistics Version 25 for Windows.

RESULTS

There was a significant difference between samples regarding different depths of preparation extension ($p<0.001$). The highest value of fracture resistance was found in samples with 6 mm extension depth (1617.43±733.46 N) while the lowest value was found in samples prepared with 2 mm extension depth (972.50±418.91 N). Pairwise comparisons showed samples prepared with different depths to be significantly different from each other ($p<0.001$). There were also a significant difference between samples regarding the type of the material where all samples of Vita Suprinity showed higher values of fracture resistance in each depth.(table 1, figure 3)

TABLE (1): Descriptive statistics for fracture resistance (N) for different groups

Material	Preparation extension (mean±SD)		p-value
	2 mm	6 mm	
Vita enamic	697.14±13.05^{C}	1370±41.4^{A}	**<0.001***
Vita suprinity	1561.71±140.33^{C}	2419.14±68.23^{A}	**<0.001***
p-value	**<0.001***	**<0.001***	

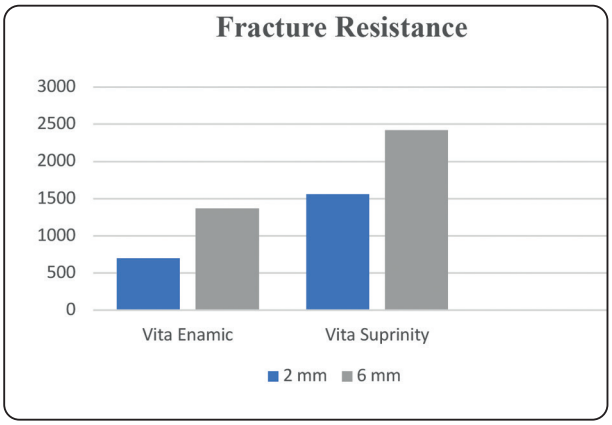

Fig. (1): Bar chart showing average fracture resistance (N) for different materials and preparation extensions (A)

DISCUSSION

To use endocrowns in Premolars or not to use this is the dilemma that needs to be answered. The initial outcome of the experiment done by **Bindl et al.**[10] suggested endocrowns as a favorable and efficient method of treatment for crown rebuilding of molars and premolars.

Thus, the bases of our study was to investigate the biomechanical behavior of endodontically treated premolars restored with endocrowns with two different depths (2mm, 6mm) and two different materials (Vita Suprinity,Vita Enamic).

Several studies reported dissimilar biomechanical behavior of different endocrown designs regarding altering pulpal extension depth[14 -16] Posterior

* IBM Corporation, NY, USA.

** SPSS, Inc., an IBM Company.

premolar-teeth were used on experiments that took place before[10,17] conducted poor performance of premolar-endocrowns when compared to molar-endocrowns in action of forces affecting occlusal areas and bond strength. This may have occurred due to the less surface area of the pulp chamber and using restoration material with weak bonding to the teeth.

Therefore, comparison of two different designs was one main concern in our study in addition to testing two different materials. There was a significant difference between samples with different depths of preparation extension were the highest value of fracture resistance regardless of the material used was found in samples with 6 mm extension depth while the lowest value was found in samples prepared with 2 mm extension depth regardless the type of the material.

This is explained because the main problem regarding the usage of endocrowns in premolars was the lack of enough surface area for bonding plus the concentration of forces on a small surface area in the pulp chamber, so when we increase the surface area of bonding and the contact between the endocrown and the tooth structure, the fracture resistance increased.

Recently, Zirconia-reinforced lithium silicate (ZLS) glass ceramic blocks for CAD/CAM use have been launched aiming to improve optical and mechanical properties relative to previous glass-ceramics systems[18-21] Vita Suprinity showed a highly significant results regarding fracture resistance under static loading than Vita Enamic in the two different depths(2mm,6mm) a zirconia reinforced lithium silicate glass ceramic (Vita Suprinity) for dental CAD/CAM usage for the construction of inlays, onlays, partial crowns, veneers, anterior and posterior crowns and anterior and posterior single tooth restorations on implant abutments has been introduced to the dental market.

Although Vita Suprinity showed significantly higher results than Vita Enamic but this doesn't mean that Vita Enamic can't be used as an endocrown material in premolars because simply Vita Enamic has a modulus of elasticity less than Vita Suprinity which mimics normal dentin therefore, when the fracture occurred during the experiment Vita Enamic endocrowns were fractured saving the tooth, while the specimens restored with Vita Suprinity the tooth was fractured.[22]

Thus the dilemma that needs to be solved is the suitability of endocrowns to restore endotreated premolars. The primary results of a clinical trial conducted by Bindl et al.[10] suggested endocrowns as a promising and efficient treatment method for crown reconstruction of molars and premolars.

It seems reasonable to hypothesize that the deeper the pulp-cavity preparation for an endocrown and the deeper the resultant intra-radicular extension, the greater the surface area for adhesive retention and the better the transmission of masticatory forces to the root [23]

This study has the following limitations; static loading was only used in this study where cyclic loading might have given more accurate and realistic results, one bonding material was only used which might not be that accurate compared to using different bonding materials, also the testing of only two ceramic material might not give more realistic results than testing more ceramic materials, also an In vitro study which doesn't convey the actual conditions of the oral cavity

CONCLUSION

Bearing in mind the limitations of this study, the following conclusions were drawn:

- Endocrown is an appropriate treatment approach for restoration of endodontically treated premolar teeth, and premolar teeth properly restored with endocrowns aren't prone to fracture under normal masticatory forces.

- Vita Suprinity showed better results regarding fracture resistance in the three different pulpal extensions.
- Vita Enamic showed better mode of fracture where the tooth can be still restorable after the endocrown fracture due to similarity of modulus of elasticity between Vita Enamic and dentin.

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