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INFLUENCE OF TWO INTRAPULPAL DEPTHS ON FRACTURE RESISTANCE OF ENDOCROWNS RESTORING MAXILLARY PREMOLAR TEETH USING ZIRCONIA REINFORCED LITHIUM DISILICATE (IN VITRO STUDY

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ABSTRACT

Purpose: This experiment got conducted to test the influence of two different intrapulpal extensions (4mm,6mm) On fracture resistance of endo-crowns restoring Maxillary premolar teeth using Zirconia Reinforced Lithium Disilicate (Vita Suprinity).

Materials and methods: 14 sound premolars were assigned to two groups (n=14), **Group A** (4 mm extension into the pulp chamber), **Group B** (6 mm extension intrapulpally). All premolars were decoronated to be 3 mm above the CEJ Proximally. After cementation, fracture resistance test was performed. Data was collected and wasstatistically analyzed..

Results: Results were significantly different between samples regarding different intrapulpal extensions were the highest value of fracture resistance was found in samples with 6 mm extension depth (2419.14±733.46) followed by samples with 4 mm depth (1961.71±659.89).

Conclusion: From the results obtained from this study, it could be concluded that endodontically treated premolars can be restored with endocrowns, moreover, the increase of the preparation depth of the endocrowns showed a massive increase in fracture resistance

KEYWORDS: Endocrowns, Premolars, Suprinity.

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INTRODUCTION

Restoring root canaled treated teeth with severely and extensively coronal loss has always had an extremely tight procedure, with the manufacture of crowns supported 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 residual dental structure[5].

On the other hand, it has been proved clinically that the usage of intraradicular posts only helped the retention of the prosthetic crown. As a result of removing healthy dentinal structure to enable the placement of stiff materials which is devoid of any mechanical behaviors similar to those of the tooth [6–9], the remaining tooth could be weakened extensively.

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 resin cements, made it possible 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 completely reinstate posterior teeth suffering from massive coronal damage by onlay and/or overlay restoration and recently through the implantation of endocrowns without the use of intraradicular posts and while incorporating the whole 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 given by the pulpal walls, and micro-retention would be acquired with the usage of new adhesive cementation. It is a way specifically suggested in cases in which there is extreme loss of hard tissues of the crown, interproximal space is limited, and traditional rehabilitation with post and crown is not applicable because of inadequate ceramic thickness.[13]

Moreover, because of the lack 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 evaluate the fracture resistance of endodontically treated premolars with extensive coronal loss, restored by two different preparation extensions into the pulp chamber using Zirconia Reinforced Lithium Disilicate (Vita Suprinity) material as endocrown restorations.

Null hypothesis:

The intrapulpal depth wouldn't affect the fracture resistance of endocrowns restoring endodontically treated premolars.

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference between different tested groups regarding fracture resistance. By adopting an alpha (α) level of (0.05), a beta (β) level of (0.2) (i.e. power=80%) and an effect size (d) of (1.58) calculated based on the results of a previous study[14] ; the predicted sample size (n) was a total of (16) samples (i.e. 8 samples per group). Sample size calculation was performed using PS Power and Sample Size Calculator 3.1.2.[15]

MATERIALS AND METHODS

Fourteen sound premolars without any seen cracks, were removed for orthodontic reasons, cleaned and stored in saline. Premolars were randomly assigned to two groups of 7 teeth each.

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 treated endodontically treated with Pro-Taper nickel-titanium (Dentsply,Sirona USA) according to the manufacturer's instructions and were obturated with gutta-percha by a vertical compaction technique.

A dental-surveyor was used to ensure upright positioning of the teeth in molds which were filled with non-shrink epoxy resin material placing the margin below the cemento-enamel junction by 1mm and parallel to the epoxy resin. The crown of all specimens were decapitated to 3 mm above the CementoEnamelJunction Mesio-Distally. Before the Two different 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 three groups according to the type of preparation extensions done,**Group A** (4 mm extension into the pulp chamber),**Group B** (6 mm extension into the pulp chamber)

The experiment was done on maxillary premolar teeth not molar teeth so this is just a diagram but actually the depth was relatively far from any furcation

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 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 (Suprinity)

Chemical Composition:

Components	Wt.-%
SiO_2	56-64
Li_2O	15-21
K_2O	1-4
P_2O_3	3-8
AI_2O_3	1-4
ZrO_2	8 -12
CeO_2	0-4
Pigments	0-6

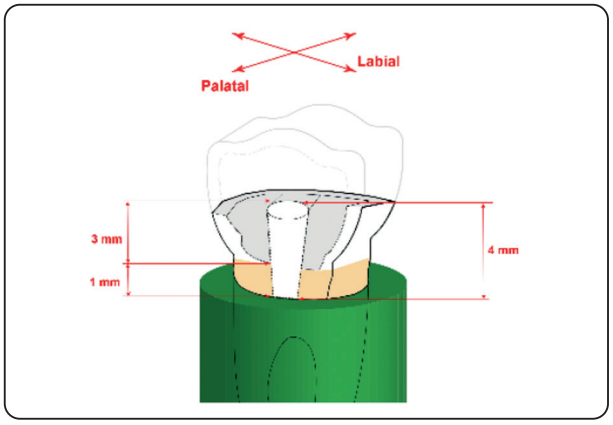

Fig. (1) Diagram showing 4 mm extension inside the pulp chamber

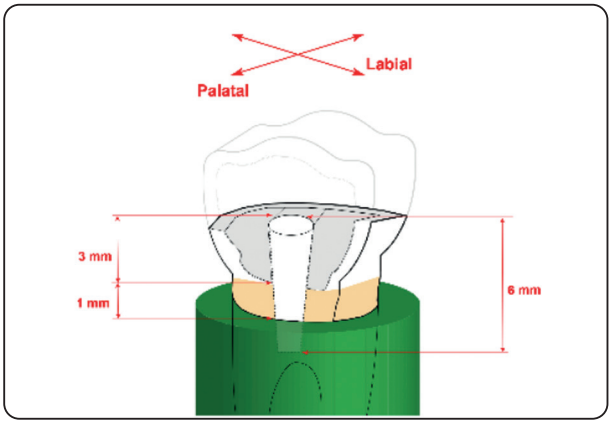

Fig. (2) Diagram showing 6 mm extension inside the pulp chamber

Physical/Mechanical Properties:

Test	VITA SUPRINITY	Standard ISO 6812
3-point flexural strength	approx. 420 MPa*1	>100 MPa
3-point flexural strength. precrystallized	approx. 180 MPa	None specified
Biaxial strength	approx. 540 MPa*2	> 100 MPa
Modulus of elasticity	approx. 70 GPa	Nome specified
Weibull modulus	approx. 8.9	Nome specified
Fracture toughness (SEVNB)	approx. 2.0 MPa $m^{-0.5}$	Nome specified
Hardness	approx. 700m MPa	None specified
CTE	approx. 12.3 $10.^{-6}$/K	None specified
Transformation temperature [TG]	approx. 620°C	None specified
Softening temperature	approx. 800°C	None specified
Chemical solubilily	approx. 40 $\mu g/cm^2$	< 100 $\mu g/crn^2$

1) The 3-point flexural strength value indicated is the average of numerous lot tests performed by VITA"s Quality Control with partially automated preparation of specimens, which resulted in lower strength values than those obtained for careful manual preparation of specimens.

2) ***cf. Materials and method. p. 8***

All samples were finished and polished according to manufacturer's instructions. The endo-crowns were first treated with Hydrofluoric acid (BISCO,USA) then Silane agent (BISCO,USA) was added for 60 seconds Then finally cemented to the corresponding samples using dual cured resin cement (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.

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 the two 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) compared to samples with 4 mm depth (1422.21±659.89).

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

Material	Preparation extension	Mean	Std. Deviation	Median	Range
Vita suprinity	**4 mm**	2248.71	86.25	2232.00	250.00
	6 mm	2419.14	68.23	2402.00	205.00

® IBM Corporation, NY, USA.
®SPSS, Inc., an IBM Company.

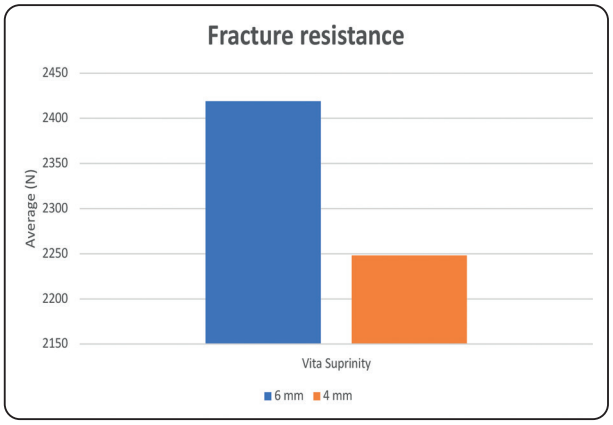

Fig. (3) : Bar chart showing average fracture resistance (N) preparation extensions (A)

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[16-18] Posterior premolar-teeth were used on experiments that took place before[10,19] 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 the main concern in our study. There was a significant difference between samples with different depths of preparation extension were the highest value of fracture resistance was found in samples with 6 mm extension depth while the lowest value was found in samples prepared with 4 mm extension depth.

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.

Vita Suprinity showed a highly significant results regarding fracture resistance under centric loading where the two different depths(2mm,6mm) gave different fracture reistance results as the 6mm intrapulpal depth showed higher fracture resistance than the 2mm intrapulpal depth therefore 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.

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 intrapulpal depth with only one ceramic material might not give more realistic results than testing different intrapulpal depths and 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.

- The endocrown pulpal extension influenced the stress distribution in endodontically treated premolars. Where extending the pulpal extension to 6 mm gave better results than 4mm.

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