

In vitro evaluation of the strength of endodontically treated teeth after preservation of soffit and pericervical dentin

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Abstract

Aim: To evaluate the strength of an endodontically treated tooth after preservation of peri-cervical dentin and soffit.

Methodology: 30 human molars having well developed cusps and morphology were extracted for periodontal reasons were included in this study. They were divided in two groups. In gp. A, Clark- Khademi access was made and endodontic treatment was carried out with 2% NiTi K-files and in gp. B, Straight line access was made and endodontic treatment was carried out with 2% NiTi K-files. Normal endodontic treatment was carried out with 2% flexible NiTi K-files with 17% EDTA as chelating agent and 5.25% Sodium Hypochlorite solution for irrigation. Obturation was carried out using the lateral condensation technique with gutta-percha coated with sealer. After this, the pulp chamber was cleaned thoroughly with cotton and all-in-one bonding agent was applied and scrubbed with an applicator tip for 30 seconds. Next, Composite restoration was done as post-obturation restoration. Specimens were then tested with a universal testing machine, set to deliver an increasing load until failure. Failure was defined as a 25% drop in the applied load. The load was applied parallel to the long axis of the tooth. The variable of interest was the load at failure measured in Newtons.

The data thus obtained was subjected to statistical analysis and was analysed using one way ANOVA test for significance with Bonferroni corrections.

Result: The teeth with Clark-Khademi access preparation with 2% taper of the endodontic files were more efficient at resisting the fracture than the teeth with straight line access preparation with 2% taper of the endodontic files.

Conclusion: The teeth after preservation of pericervical dentin and soffit were found to be structurally reinforced as compared to the teeth with straight line access. Clark-Khademi access preparation was found to be more effective at dentin preservation and strengthening the tooth when compared to straight line access.

Keywords: Soffit, pericervical dentin, Strength of endodontically treated teeth.

Introduction

Access cavity preparation is the first and arguably the most important phase of root canal treatment. A well-designed access preparation is essential for a good endodontic result. Without adequate access, instruments and materials become difficult to handle properly in the highly complex and variable root canal system.⁽¹⁾

A properly prepared access cavity creates a smooth, straight- line path to the canal system and ultimately to the apex. Ideal access results in straight entry into the canal orifice, with the line angles forming a funnel that drops smoothly into the canal(s).⁽²⁾

A Traditional access cavity generally has tapering walls with its widest dimension at the occlusal surface. Stainless steel files were used which were stiffer and were not so efficient in negotiating the curvatures of the root canal. To counter this, a large wider access preparation was advised.^(3,4,5) But, wider access preparation done traditionally, resulted in unnecessary dentin removal and hence weakening of the tooth structure. The advent of Nickel-titanium instruments paved way for more conservative access preparations, as these files are super elastic and flexible which can negotiate the canal curvatures easily. Drs. Clark and Khademi have described a concept of conservative endodontic access cavity preparation. This concept

negates the traditionalist straight-line access protocol and the total deroofting of the pulp chamber.⁽⁶⁾

Drs. Clark and Khademi have coined the term “soffit”, which is a small piece of dentin roof around the entire pulp chamber, to preserve the critical region of peri-cervical dentin (PCD) that is 4mm above and below the crestal bone, without compromising debridement and without inducing iatrogenic misadventure. This type of more constrained, constricted and conservative access cavity encourages the preservation of dentin, thus increasing the strength of the remaining tooth structure and thus prevents the chances of fracture of the tooth.^(3,6) The prognosis of endodontically treated teeth depends not only on the success of the treatment but also on the amount of remaining dentin. Fractures of restored endodontically treated teeth are a common occurrence in clinical practice, due to excessive removal of dentin.⁽⁷⁾ So improvement in the access cavity preparation to save the unnecessary removal of dentin is required.⁽⁶⁾

In light of these observations, we had planned to evaluate the strength of an endodontically treated tooth after preservation of dentin at the soffit region and at the pericervical area.

Methodology

Thirty human molars having well developed cusps and morphology were extracted for periodontal reasons were included in this study. The teeth were without caries, anomalies and fractures. This study was conducted in the Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth Deemed University Dental College and Hospital, Pune.

The teeth were randomly divided into two groups as follows:

Groups	Sample size	Procedure
Group A	15	Clark- Khademi access design was made and endodontic treatment was carried out with 2% NiTi K-files.
Group B	15	Straight line access was made and endodontic treatment was carried out with 2% NiTi K-files.

- **Group A (n=15):** A Large Round bur was used to create the initial access. The central pit of the teeth was selected as the reference point for guiding the bur into the pulp chamber. The position of the bur was held parallel to the long axis of the tooth as all times. After the initial drop into the pulp chamber, a DG-16 probe is used to locate the canals by tactile sensation.

The back end of the explorer or probe is used to check for "soffit," which is the dentin roof around the entire coronal portion of the pulp chamber. A X-ray was made at this stage of the access preparation to check for the soffit radiographically.

- **Group B (n=15):** A Large round bur was used to create the initial access. After the initial drop into the pulp chamber, an endo-access preparation bur was used to widen the access preparation till the bur reaches the walls of the pulp chamber, so that a straight-line access was made. A X-ray was made at this stage to check for the straight line access radiographically.

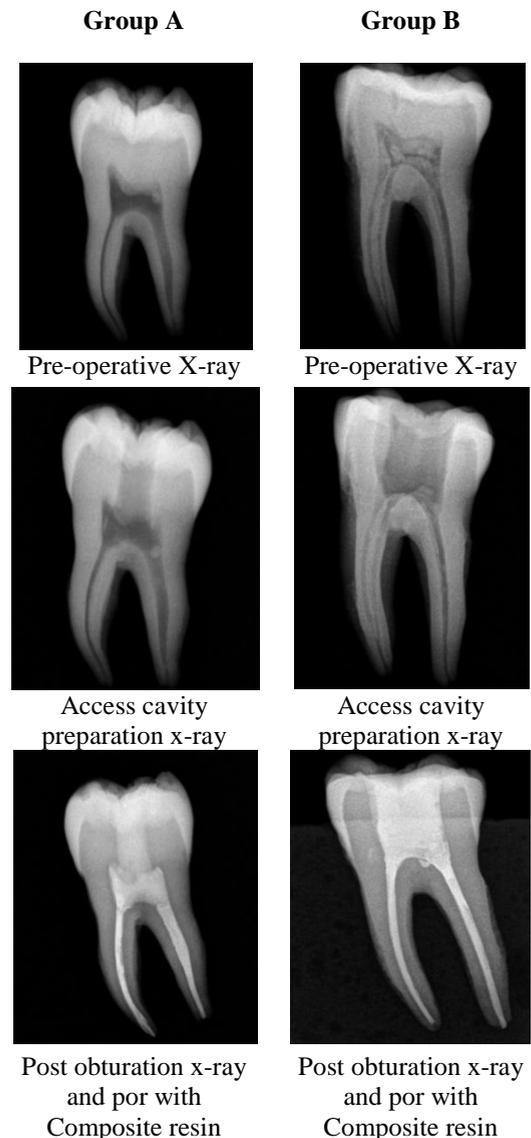
For Groups A & B - After confirming the X-ray's respectively, normal endodontic treatment was carried out with 2% flexible NiTi K-files with 17% EDTA as chelating agent and 5.25% Sodium Hypochlorite solution for irrigation. Obturation was carried out using the lateral condensation technique with gutta-percha coated with sealer.

After Obturation was carried out for all the groups, the pulp chamber was cleaned thoroughly with cotton and all-in-one bonding agent was applied and scrubbed with an applicator tip for 30 seconds. After this, another drop of bonding agent was applied and scrubbed again for 30 seconds and then light cured.

Next, Composite was added in small increments (gently tapped with the applicator tip) to adapt properly in the pulp chamber and light cured after every increment. Composite instruments were used to gently carve the occlusal anatomy of the tooth.

Specimens were then tested with a universal testing machine, set to deliver an increasing load until failure. Failure was defined as a 25% drop in the applied load. The crosshead speed was 1 mm per minute, and the load was applied parallel to the long axis of the tooth. The variable of interest was the load at failure measured in Newtons.

The data thus obtained was subjected to statistical analysis and was analysed using one way ANOVA test for significance with Bonferroni corrections.



Statistical analysis

The compressive strength of the samples prepared in each group was expressed as means and standard deviations (mean \pm SD). The between group comparison

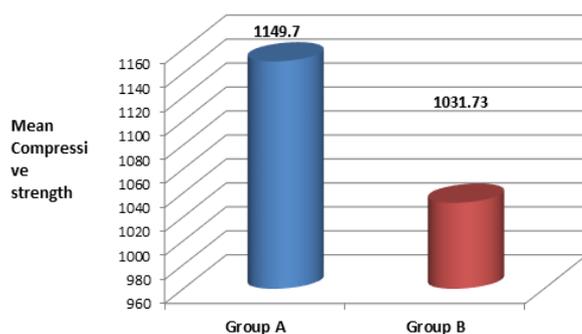
of compressive strength of samples in Group A and B was done using One- way ANOVA test. Within group comparison was done using Bonferroni correction test. In the tests, p value of ≤ 0.05 was considered as statistically significant.

Results

Table 1: Comparison of compressive strengths of the samples in Group A (soffit 2%) and Group B (2% straight line access)

Compressive strength, Newton	Group A	Group B	P value (One way ANOVA)
Mean	1149.70	1031.73	0.001*
Standard deviation	111.35	71.36	

*p<0.05 is statistically significant



Discussion

Endodontically treated teeth are proved to be weaker than vital teeth and are known to present a higher risk of fracture failure when compared to the vital teeth. Hence attention should be paid to unnecessary dentin removal during endodontic treatment, in order to maintain the strength of the teeth.⁽¹⁸⁾ Access cavity preparation is the first and arguably most important phase of root canal treatment. A well-designed access preparation is essential for a good endodontic result. Without adequate access, instruments and materials become difficult to handle properly in the highly complex and variable root canal system.⁽¹⁾ The objectives of access cavity preparation is not only to create a smooth, straight-line path, debridement of the entire canal system, to reduce the risk of file breakage but also to conserve the sound tooth structure, especially at the peri-cervical area of the tooth.⁽²⁾ Traditional endodontic design adheres to straight line access, de-roofing of the pulp chamber and pre-flaring the coronal one-third of the root canal to facilitate the shaping of the entire root canal system in order to negotiate the apical terminus. In order to achieve these objectives, a large amount of tooth structure was compromised.⁽¹⁾

Gutmann JL et al (1992) noted in his study that there is an excessive removal of radicular dentin during canal

cleaning and shaping. The authors also noted that the decrease in the strength of endodontically treated teeth is the result of alteration of coronal tooth structure, which ultimately causes the loss of strength of the tooth.⁽¹¹⁾ Christine Sedley, Harold Messer (1992) reported that endodontically treated teeth had 35% lesser stiffness values when compared to the vital teeth.⁽⁹⁾

Drs. Clark and Khademi have described the concept of conservative endodontic access preparations by preserving the peri-cervical dentin and 'soffit', thereby negating the traditional straight line access and the totality of de-roofing the pulp chamber. Soffit is a small piece of roof of the dentin around the entire pulp chamber, and the peri-cervical dentin, that is 4 mm of dentin above and below the level of crestal bone.^(3,4,5)

Papa et al emphasized the importance of conserving the bulk of dentine to maintain the structural integrity of post-endodontically restored teeth.⁽¹⁹⁾ Asudi et al have emphasized that the loss of tooth structure is the key reason for the increase in fracture predilection of endodontically treated teeth.⁽⁷⁾

In light of these observations, the present study was conducted to evaluate and compare the effect of conserving dentin at the region of peri-cervical dentin and soffit, on the strength of the tooth, with two different types of access preparations.

For this study, molar teeth were collected. As the molars absorb a more vertical force and, thus the higher net compressive force.⁽⁴⁾ Teeth were divided into two groups. Group A consists of Clark- Khademi style access preparation and endodontic treatment was carried out with 2% NiTi K-files. As 2% Taper files are less aggressive in dentin removal, and thus help in preservation of soffit and pericervical dentin. Group B consisted of Straight-line access preparation and endodontic treatment was carried out with 2% NiTi K-files. Group B also uses 2% taper files but with straight line access. This group represents the conventional endodontic technique, which is still in use by majority of the clinicians.⁽⁶⁾

During the complete bio-mechanical preparation, 5.25% Sodium Hypochlorite solution was used as an irrigating solution along with 17% EDTA as a chelator. NaOCl possesses a broad spectrum antimicrobial property, dissolvent of organic tissue and also lubricates the canal for efficient instrumentation. EDTA chelates a stable calcium complex with dentin mud which helps in removing of canal obstructions and thus further aids in instrumentation.

Gutta-percha was used as an obturating material in both the groups as it is the universally accepted core material used for obturation. Sealapex (Sybron-Endo) was used as the sealer in all the groups. Sealapex is a Calcium hydroxide based sealer which exhibits antimicrobial activity.

For the post obturation restoration, Composite material, with all-in-one bonding system was chosen for all the 3 groups. In a study by Trope et al, he concluded

that acid etching and restoration with a composite resin strengthened the endodontically treated teeth.⁽¹⁷⁾

The teeth were embedded in auto-polymerising acrylic resin blocks upto the cemento-enamel junction. The dimensions of the acrylic block were 15mm X 15mm X 20 mm. This dimension was chosen so that all of the root surface area was adequately covered by the resin and also a sufficient margin of resin was left from the tooth surface, so that the sample does not undergo pre-cracking while testing under load.

Universal Testing Machine was used to evaluate the fracture strength of the specimens which was set to deliver an increasing load until failure. Failure was defined as a 25% drop in the applied load. The crosshead speed was 1 mm per minute, and the load was applied to the central pit of the tooth, parallel to the long axis of the tooth. The method of testing was fatigue loading so as to simulate the dynamic forces that act onto the tooth during mastication and swallowing.^(4,5) The results were obtained and statistically analyzed.

Table 1 showed that both the groups could more or less resist the compressive loads; with Group A showing the most statistically significant difference when compared to Group B, that is the Clark-Khademi access preparation with 2% taper of the endodontic files was the most efficient at resisting the fracture than Group B which has straight line access. The reason for this would be the banking of tooth structure; that is dentin preserved at both pericervical region and the soffit. Gutmann JL et al also showed that the mechanical integrity provided by even a small part of the roof of the pulp chamber allows for greater flexure of the tooth during function.⁽¹¹⁾

Dentin is primarily a collagen-rich organic matrix reinforced by calcium phosphate mineral particles. The constituents of dentin material are efficiently optimized to different mechanical demands in the mouth. Often, endodontically treated teeth experience tissue loss due to prior pathology or treatment procedures. The loss of dentine tissue will compromise the mechanical integrity of the remaining tooth structure.⁽⁷⁾

The approach of banking of tooth structure in restorative dentistry dictates that whenever possible, more tooth structure should be preserved. It may involve a less expedient, but more conservative, approach. This banked tooth structure may serve as a valuable future asset in the advent of unforeseen future trauma or disease, coupled with the reality that a tooth will need to last for decades and potentially be restored and then reresored in the patient's lifetime. The primary reason to maintain the soffit is to avoid the collateral damage that usually occurs, by the gouging of the lateral walls.^(4,5)

'Soffit' is totally a new concept in access cavity preparation and further research is required to be done on more number of samples to check the strength of the tooth. Research will certainly need to be done to validate other parameters like complete debridement, cleanliness, disinfection etc. with soffit preparation.^(4,5,6)

Conclusion

Within the limitations of this in vitro study following conclusions were made:

1. The teeth after preservation of peri-cervical dentin and soffit were found to be structurally reinforced as compared to the teeth with straight line access.
2. Clark-Khademi access preparation was found to be more effective at dentin preservation and strengthening the tooth when compared to straight line access.

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