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Evaluation of temperature change in the root surface during post space preparation using two different drill systems– An invitro study.

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Abstract:
Objective(s): *The aim of this study was to measure the temperature changes along the root surface during post space preparation procedure using two different post space preparation drill systems with the use of thermocouple device.*
Materials and methods: *Twenty extracted human permanent mandibular central incisors were selected and decoronation was done to obtain a tooth length of 19mm. Cleaning and shaping was done using Dentsply Protaper Universal Treatment (Rotary file) upto F1 file. Single cone obturation done with sealapex sealer. Coronal access was restored with type IX Glass ionomer cement and teeth was incubated for 1 day and will be randomly divided into two experimental groups. FRC postec plus (Fiber Reinforced Composite) post drill was used in Group 1, and Para post drill was used in Group 2 with ten specimen in each group. A 14 mm post space was prepared in all root canals at 1000 rpm. Each post space preparation drill was used inside the root canal for 30s for post space preparation and temperature was measured with thermocouple device.*
Statistical analysis: Data was compared by using Mann Whitney U-test.
Results: *Two different drill system created a certain degree of temperature change. Parapost drill system caused less temperature rise than FRC (Fibre Reinforced Composite) Postec plus drill system.*
Conclusion(s): *The maximum temperature rise was observed in FRC post drill when compared with Para post drill system and there was a significant difference among the two groups.*
Keywords*: Endodontics; temperature increase; thermal analysis.*

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I. Introduction

Endodontic therapy involving root canal preparation, obturation, post-space preparation and post cementation could produce thermo-mechanical alterations to the teeth[1].

The aim of endodontic therapy of the necrotic or irreversibly diseased pulp is to allow the preservation of the tooth structure as a healthy functional unit.[2]

Endodontically treated teeth have an increased fragility due to decay, the endodontic access preparation and previous restoration.[3] The restorations of these teeth should be done in a way that replaces the missing coronal structures and placement of remaining 4-5 mm gutta-percha apically, it restores the function and protect the endodontic space from reinfections.[4]

Promoting the reinforcement of the final restoration of such severely damaged teeth is usually treated with post and core system,[3] a post is indicated to retain and improve the distribution of the functional loads to the root. The root canal treatment and post and core rehabilitation change the normal stress and strain distribution patterns inside the teeth, reducing the resistance to fracture.[1]

The preparation of the post space involves removing a part of the root canal filling material and enlargement and shaping of the root canal.[5] Temperature rise with in the root is transmitted to that of the surrounding periodontium, as the root is totally within the mass of tissue having an extensive blood supply[6]

During various procedures, such as restoration of the tooth and endodontic treatments, there will be a marked rise in temperature of the dental structures and the periodontal tissues, that leads to damage of the tooth and its supporting structures correspondingly. [2]

Dentin has a low thermal conductivity, but the heat produced by the preparation procedures in root canal may pass on to the root surface, which is a potential insult to the periodontal ligament (PDL) and adjacent bone[2].

Temperature elevations of 10°C above body temperature, of duration greater than 1 min, may be sufficient to cause bone tissue injury. Rise in temperature above critical 45°C causes surface resorption of the cementum and bone ankylosis.[2] Moreover, temperature increase up to 53ºC for 1 min resulted in cessation of blood flow [8]

Since the measurement of root surface temperature change is practically not feasible in an in vivo condition, this study model was selected to mimic the clinical scenario which will help us to measure the root surface temperature change simultaneously when the post space preparation is done in the root canal.

The aim of this study was to measure the temperature changes along the root surface during post space preparation procedure using two different post space preparation drill systems.

The objective of this study was to measure the temperature changes along the root surface during post space preparation procedure using two different post space preparation drill systems using device thermocouple.

II. Materials & Methods

Ethical:

The research proposal was presented in the Institutional ethical committee vivekanandha dental college for women and the study design was approved. (NO: VDCW/IEC/201/2019)

1. Teeth samples (sample selection):

A total of twenty extracted human permanent mandibular central incisors were selected with single root canal extracted for periodontal reasons and were stored in saline solution. All calculus and tissues were removed completely from the surfaces of the teeth. Teeth with calcified canals, internal and external root resorption and fractured teeth were excluded. To confirm the single root canal anatomy, preoperative radiographs of each tooth samples were taken from two directions (mesiodistal and labiolingual).

Root canal preparation:

Decoronation was done with diamond disc along with water coolant, such that the measurement of 19mm tooth length were obtained for each tooth. The root canals preparation was done with Dentsply Protaper Universal Treatment (Rotary file) in a sequential manner up to F1 file with chelating agent 17% ethylenediaminetetraacetic acid (EDTA gel Prime Dental RC Help) and irrigated with 5 ml of 3% sodium hypochlorite solution (Chemdent sodium hypochlorite) and alternative 5 ml of saline irrigation. When the preparations of root canals are finished, 5ml of 17%EDTA solution (Prevest Denpro EDTA Solution) was used for smear layer removal.

Master cone was verified with corresponding gutta percha (Dentsply Protaper Universal Gutta Percha Points), such that tugback effect is felt in the apical region. Final irrigation was done with distilled water. Root canals were then dried using paper points. Root canals were coated with sealer (Sealapex) (Kerr Sybron Endo Sealapex Canal Sealer) using lentulospiral (Size-25). The root canal was obturated with gutta percha using single cone obturation technique. Coronal access was restored with Glass Ionomer Cement (GC Gold Label 9 Posterior Restorative GIC) and teeth was incubated (RI-18H- Rotek laboratory instrument) for 1 day at 37℃ in an incubator.

Tooth model and thermocouple apparatus set up:

Eppendorf tube was completely filled with alginate impression material to mimic the periodontal ligament because its water content is very similar to the water content of the human body. The root was embedded within the alginate upto cementoenamel junction and acrylic resin was used to stabilize the tooth at cementoenamel junction level.[2]

Four minute opening done in eppendorf tube, two in coronal third and two in middle third respectively. The root surface were exposed in this region for attaching the thermocouple probe to the root surface for the measurement of temperature change and connected to the thermometer (RDT Module-VI Microsystems pvt ltd). Eppendorf tube was submerged in the water bath up to apical level. Temperature of water bath was maintained at 37˚C.[2]

Post space preparation and temperature measurement:

Post space preparation was done with Parapost, FRC postec plus drill system. Samples were randomly divided into two groups with 10 samples in each group.

The groups were follows:

Group 1: FRC postec plus post drill (Ivoclar Vivadent)

Group 2: Parapost drill **(**coltene whaledent parapost**)**

The drills were used at 1000 rpm in endomotor (Dentsply X-Smart Plus Endodontic Endo Motor) for post space preparation upto 14 mm into the root canal. The temperatures were measured at two locations: middle third and

coronal third of the root. Each post space preparation drill was used inside the root canal for 30 seconds. During the post space preparation reading with highest temperature was noted.

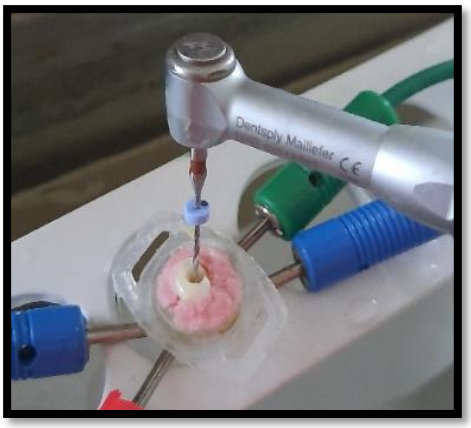

Fig:1 Post space preparation

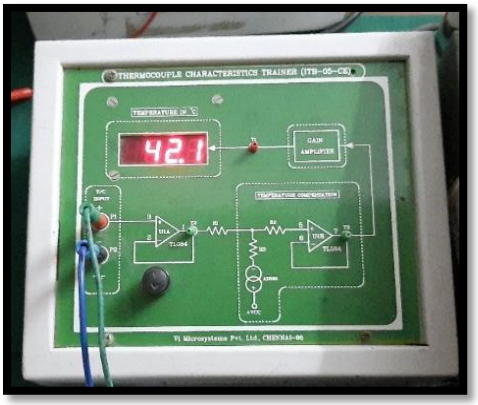

Fig:2 Thermocouple

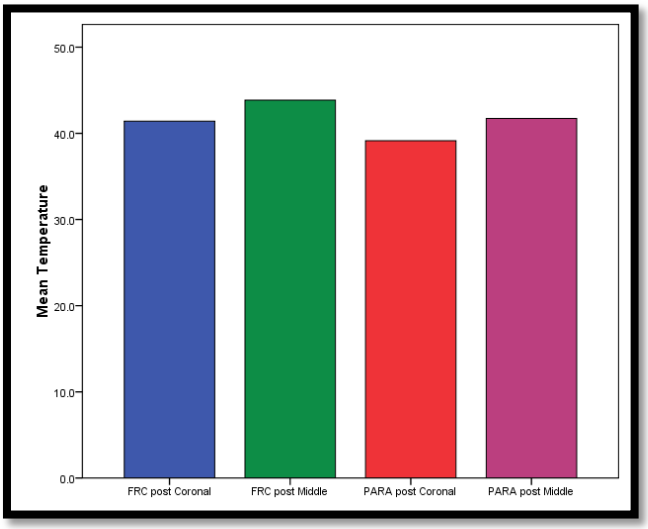

Fig:3 The mean temperature rise during post space preparation

III. Results:

The temperature was measured at the coronal and middle third of the root during the procedure:

When the comparison of means was done between the coronal and middle portion of the FRC post and the Para post which reveals that the Para post was better which has a lesser mean temperature of about 39.140±0.9371 in coronal portion and41.730±1.2139 in middle portion when compared to the FRC post.

Table 1 - Mean and standard deviation of temperature of the two experimental groups

Groups	N	Mean	Std. Deviation	Minimum	Maximum
FRC post – Coronal	10	41.410	1.0279	39.3	42.3
FRC post – Middle		43.850	2.2471	42.0	45.2
PARA post – Coronal	10	39.140	0.9371	38.1	41.0
PARA post – Middle		41.730	1.2139	40.6	44.4

The mean and standard deviation of temperature was 41.410±1.0279, 43.850±2.2471, 39.140±0.9371 and 41.730±1.2139 for the FRC post coronal, FRC post middle, Parapost coronal and Para post middle portions respectively.

Table 2 – Intergroup comparison of the mean temperature at the coronal portion between the two experimental groups

Temperature	Mean	Std. Deviation	Mean Rank	p-value
FRC post	41.410	1.0279	15.00	0.001*
PARA post	39.140	0.9371	6.00	

When the comparison of means was done between the coronal portion of the FRC post and the Para post which reveals that the Para post was better which has a lesser mean temperature of about 39.140±0.9371 when compared to the FRC post which sho

Table 3 – Intergroup comparison of the mean temperature at the middle portion between the two experimental groups

Temperature	Mean	Std. Deviation	Mean Rank	p-value
FRC post	43.850	2.2471	14.00	0.008*
PARA post	41.730	1.2139	7.00	

When comparing the means of the middle portion of the FRC post and the Para post which shows that the Para post was better which has a lesser mean temperature of about 41.730±1.2139 when compared to the FRC post and the result shows a statistically significant p-value of 0.008.

STATISTICAL ANALYSIS:

The statistical analysis was done by using SPSS VERSION 25.0. The Mann Whitney U– test was used to compare the mean between the two experimental groups. The statistical significance was kept at p – value less than 0.05.

IV. Discussion:

Post space preparation produces rise in temperature within the root dentin that might be transmitted to the attachment apparatus.[1] The critical temperature for bone injury, occurs at 56˚C where bone alkaline phosphatase is rapidly inactivated.[3] Temperature increase greater than 10˚C above body temperature could be harmful to the cementum, periodontal ligament and alveolar bone[7] and causes protein denaturation in the periodontal ligament, tooth ankyloses and interrupts the blood flow.[13,14]

Post space preparation drills not only remove the root filling, but also prepare the walls of the root canal and are matched to a particular post configuration.[12] The post space preparation drills inside the root canal produce heat which transmits to the outer root surface.[4] The post space preparation should not disturb the obturation at apical third of the root canal. In our study, 14 mm post space was standardized in all root canals with the apical seal of approximately 5 mm [16].

Gokturk et al in 2015 conducted a study to measure the temperature rise during post space preparation using 3 different post drill system(Snowpost, Relyxpost, Rebilda post) in mandibular central incisor and stated that snowpost 2 showed maximum temperature rise, but there was no significant difference(P>0.05) among snowpost 2 and snowpost 1 and there was no significant difference(P>0.05) among relyx 2 post and relyx 1and there was no significant difference(P>0.05) among Rebilda post2 and Rebilda 1.Rebilda showed least temperature rise and found similar result that the parapost showed less temperature than FRC postec plus.[3]

When the root canal walls are thin, it can transmit greater amount of heat. [11] Mandibular incisor was selected for this study because of smaller root dentin thickness which might transfer more heat to periodontal tissues.

There are two modes to measure the temperature on the root surface. One is the direct contact mode with thermocouples and other is non-contact mode-infrared thermometers. [3,4] The device used for direct contact mode is thermocouple, that measures the temperature of localized point on the root surface. Hence this direct contact mode thermocouple device has been used for this study. Eriksson, Sundstrom and Saunders in 1989 measured temperature alteration on the root surface during preparation of post space using thermocouple [3].

Higher revolution per minute (rpm) causes more friction which ultimately leads to heat generation. Norman weller et al in 1996 conducted a study on root surface temperature during post space preparation with (Gutta percha remover) GPX bur in different rotational speed of 6500,8000,9500,11000,15000 rpm and concluded that temperature increased during preparation at speed >8000 rpm and lowest temperature increase produced at 6500rpm.[5]

In the above study norman weller stated that highest temperature recorded were at the corornal part of root canal. This may be because of larger root canal diameter in coronal part of maxillary central incisor. But in this study, highest temperature were recorded in the middle third of root canal in compare to coronal third of root canal.[3]

Gokturk et al in 2015 did a study and stated that higher temperature rise was seen in the middle third of root in compare to coronal third and had a similar result in this study.[3]

In this study revolution per minute (rpm) used for the post space preparation, drill was set at 1000rpm, for time period of 30 seconds with which we achieved optimal post space preparation length (14 mm of post space preparation). The maximum temperature rise was noted in FRC post drill around 7˚C above the body temperature (37˚C).

When the temperature rise was evaluated in the coronal third and middle third of the root in all the tooth samples, during the initial phase of the post space preparation, post drills prepared the coronal third of the root structures. In coronal portion, it reveals that the Parapost was better which has a lesser mean temperature of about 39.140±0.9371 when compared to the FRC post which shows a significant p-value of 0.001.[3] In middle portion, it shows that the Parapost was better which has a lesser mean temperature of about 41.730±1.2139 when compared to the FRC post and the result shows a statistically significant p-value of 0.008. During the preparation of middle third, post drill reached the working length and the post drill had been in contact with canal wall throughout the entire post space, this situation caused a maximum temperature rise during post space preparation in middle third of the root.[3]

V. Conclusion

Within the limitations of this study, the maximum temperature rise was observed in FRC post drill when compared with Parapost drill, but there was a significant difference among the two groups.

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