Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 8, July 2021: 4014 - 4019

In Vitro Evaluation of Temperature Increase on the External Root Surface During Root Canal Shaping using Single File System

Dr.Neelam.Chandwani[a], Dr DollyJagyasi[b], ,Dr. VandanaGade[c],Dr. Swapnil Kolhe[d],Dr. Nikhil. Mankar[e],Dr.SuparnaKosta[f]

[a]MDS, Conservative Dentistry and Endodontics ,Assistant Professor, Dentistry Department, All India Institute of Medical Sciences Nagpur, Maharashtra, India.
[b]MDS, Conservative Dentistry and Endodontics, Nagpur, Maharashtra, India.
[c]Professor, Department of Conservative Dentistry, SwargiyaDadasahebKalmeghSmruti Dental College and Hospital , Nagpur, Maharashtra, India
[d] Professor, Department of Conservative Dentistry and Endodontics, MGV'sKBH Dental College and Hospital , Nashik, Maharashtra, India
[e] Reader, Department of Conservative Dentistry and Endodontics, Sharad Pawar dental college and Hospital, Datta Meghe Institute of Medical Sciences, Deemed to be University, Sawangi, Meghe, Wardha, Maharashtra, India.
[f]MDS, Conservative Dentistry and Endodontics, Jagdalpur, Chhattisgarh, India

Abstract

During rotary instrumentation frictional force generates heat along the root canal walls due to difference in velocities between the two sliding surfaces.Surface and near surface temperatures can become raised enough to cause changes in the structure and biological behaviour of the adjacent tissues may cause complications like tooth ankylosis, bone necrosis and resorption.

Objective: The study aims to evaluate the temperature changes on the external root surface during root canal preparation with three different single file rotary systems in vitro.

Materials and Methods:

The study was approved by institutional ethical committee. Sixty sound mandibular first premolars were collected. Access cavity was prepared and working length was determined by placing a size 15 K file until the tip was observed at the apical plane. All root canals were instrumented using a size-20 K-type hand file until the file moved freely within the canal. The teeth were mounted vertically into self-curing 4 mm acrylic resin rings, and the root surfaces were exposed. The samples were randomly divided into three groups of 20 teeth each according to the 3 experimental single file systems. During the tooth preparations, the temperature changes were measured for all samples using a noncontact infrared thermometer.

Statistical analysis

The Kruskal– Wallis analysis of variance was used for statistical analysis. The level of significance was 5% ($P < 0.05$).

Results: The temperature increase caused by the Neolixneoniti file system were lower ($P < 0.05$) whereas Wave One file caused the maximum temperature increase.

Conclusion

NeolixNiTi file is safer than Wave One and One curve single file sytems in context of temperature rise in the external root surface. This may help avoid the harmful effect on the periodontium while shaping the canal in clinical situation.

Keywords: Nickel titanium alloy, root canal preparation, external root surface.

1. Introduction

The prime objective of endodontic treatment is thorough debridement and cleaning of infected root canal system, hermetic sealing of the root canal space thereby preventing or minimizing the chances of reinfection. Nickel-titanium rotary instruments has gained wide acceptance in endodontics as they appear promising and effective instruments for cleaning and shaping, reduced the time spent on operative procedures, sensitivity and complication risks. During rotary instrumentation frictional force generates heat along the root canal walls due to difference in velocities between the two sliding surfaces **(Hardie, EM. 1987).** Surface and near surface temperatures can become raised enough to cause changes in the structure and biological behavior of the adjacent tissues may cause complications like tooth ankylosis, bone necrosis and resorption (**Eriksson, A. R., &Albrektsson, T. 1983).**The study by Eriksson and Albrektssonrevealed the detrimental effects of increased temperatures on alveolar bone and periodontal ligament. They reported that a temperature increase of 10°C on the outer root surface caused bone resorption and tooth ankyloses **(Eriksson, A., Albrektsson T., Grane B., & McQueen D. 1982).** In 1982, Eriksson and Albrektsson in another study indicated that exposing the bone to a temperature of 53°C for 1 min interrupted the blood flow. In 1988; Sauk et al observed the exposure to a temperature of 43°C may result in protein denaturation in the periodontal ligament **(Sauk, J. J., Norris, K., Foster, R. A., *et al* 1988).**

Manufacturers have developed instruments made from new alloys and new working motions, such as reciprocation to improve the fracture resistance of NiTi rotary files. The reciprocating motion is caused by special movements identified by counterclockwise (cutting action) and clockwise (release of the instrument) motions. It is reported that this movement reduces stress on the file and the risk of cyclical fatigue caused by tension. The Wave One (Dentsply Maillefer, Ballaigues,Switzerland) single file system is an example of instruments that use this concept. Another new example of a single file instrument using continuous clockwise rotation is the One Curve (Micro Mega, Besancon, France) and NeolixNeoniti (Neolix, châtres-la-Forêt, France).

Various methods have been used to measure tissue temperature with or without contact. Thermocouples and subgingival thermometer measure temperature based on contact with tissue. These instruments may be inconvenient because of the difficulties involved in surgery and

sterilization. Infrared thermometers can measure the tissue surface and determine only the superficial temperature without contact.

2. **Objectives**

The present study aimed to evaluate the temperature changes on the external root surface during root canal preparation with three different single file rotary systems in vitro.

3. Hypotheses of The Study

There is no difference in the temperature change on the external root surface during root canal preparation with three different single file rotary systems.

4. Materials and Methods

The current study was approved by the Institutional Ethical Committee with the approval number CDCRI/DEAN/ETHICS/COMMITTEE/CONS-02/2018. Sixty human mandibular first premolar teeth which have been extracted for orthodontic reasons within a period of one month were collected from the department of Oral and Maxillofacial Surgery, and used for this study. Soft tissue debris and the calculus were mechanically removed from the surface of the root with help of an ultrasonic scaler and cleaned under running tap water. The teeth were stored in purified distilled water. Radiographs were taken to confirm the full development of tooth, absence of root filling, internal resorption and calcification and to verify the presence of single canal. Those teeth with aberrant root canal anatomy, more than one canal and tooth having more than 30° curvature were excluded from the study for the uniformity. Initial access obtained with a No.2 round bur and apical patency of each specimen was obtained by inserting an ISO size-10 K file (Dentsply,Maillefer) until the tip was observed at the apical plane. Working length was then determined by placing a size- 15 K file (Dentsply,Maillefer) into the canal space until it is appeared at the apical plane. All root canals were instrumented using a size-20 H-type file (Dentsply,Maillefer) until the file moved freely within the canal. The canals were irrigated with 3% sodium hypochlorite solution (PRIME DENTAL PRODUCTS PRIVATE LIMITED). The teeth were mounted vertically into self-curing 4 mm acrylic resin rings, and the root surfaces were exposed. The samples were randomly divided into three groups of 20 teeth each according to the endodontic files used for root canal. The groups were the following:

Group 1: WaveOne Endodontic File no: 25 (taper 8% that reduces towards the coronal end, tip size-ISO25) (Dentsply Maillefer, Ballaigues, Switzerland).

Group 2 :NeolixNeoniti A1 File no. 25 (taper 6%, tip size- ISO25) (Neolix, châtres-la-Forêt, France).

Group 3: One Curve File no. 25(taper-6%, tip size-ISO25) (Micromega, France).

Group 4: Temperature rise (T_0)of each rotary file before each preparation

Each instrument was used according to the manufacturers' instructions, and file systems were used inside the root canal for 60 sec in all groups. Before each canal preparation, EDTA (RC-Prep , Prime Dental Products P Ltd) was used as a lubricant. During the tooth preparations, the temperature changes were measured using a noncontact infrared thermometer (Optris LS LT, Berlin, Germany)

with a sensitivity of 0.1°C at the middle third of the roots. Instruments were used for 60 sec in root canals to watch thermal changes after access to the apices. Five teeth were examined as controls by measuring the temperature alterations for 60 sec without any preparation. This was performed to determine whether the infrared thermometer caused any temperature change.

5. Statistical analysis

The Kruskal– Wallis analysis of variance was used for statistical analysis. The level of significance was 5% ($P < 0.05$).

6. Data analysis and Interpretation

The mean temperature increases and standard deviations for the experimental groups are shown in **Table 1**.

Groups		Mean	SD	SE	95% Confidence interval	
					Lower bound	Upper bound
wave one file	Group 1	26.92	0.12	0.03	26.86	26.98
NeolixNeoniti file	Group 2	26.26	0.23	0.05	26.16	26.36
One Curve File	Group 3	26.57	0.18	0.04	26.49	26.65
T0 of Wave one, NeolixNeoniti and One curve file before preparation	Group 4	25.39	0.21	0.05	25.29	25.49
Control	Control	25.36	0.27	0.06	25.24	25.48

Table 2 shows the significance of difference in mean temperature rise for different rotary system using non parametric kruskal -Wallis test. All the comparison except between Group 4 (T_0 of each rotary file before preparation) and control was found highly significant.

Comparing groups	"H"	P value
Group 1 vs Group 2	26.94	<0.001
Group 1 vs Group 3	24.54	<0.001
Group 1 vs Group 4	24.54	<0.001
Group 1 vs Control	11.95	<0.001
Group 2 vs Group 3	16.65	<0.001
Group 2 vs Group 4	29.46	<0.001
Group 2 vs control	11.7	<0.001
Group 3 vs Group 4	29.58	<0.001
Group 3 vs control	11.9	<0.001
Group 4 vs control	0.076	p=0.73 NS

The temperature increase caused by the Neolixneoniti file system were lower than those of the other files ($P < 0.05$). An evaluation of all groups showed that the WaveOne file caused the highest

temperature increase. All the groups showed significant difference except group 4(Temperature rise (T_0)of each rotary file before each preparation) and control group (Table 2) .

7. Discussion

This present in vitro study evaluated the effect of temperature increase on the external root surface during endodontic treatment using Wave One, Neolixneoniti and One curve Single file systems. The heat generated during a root canal preparation may affect the root surface, periodontal ligament and adjacent alveolar bone. It has been reported that a temperature increase >10°C could be harmful for cementum, periodontal ligament, and alveolar bone tissues **(Eriksson, R. A., &Albrektsson, T. 1984).**The anatomy of root canal and the amount of residual dentin thickness, the extent of contact between the instrument and canal wall, intermittent or continuous instrument usage and the operator force are the factors which affect the amount of heat transmission **(Eriksson, J. H., &Sundström, F. 1983) (Mc Cullagh, J. J. P., Setchell, D. J., Gulabivala, K., *et al*. 2000)**. Owing to its low thermal conductivity, residual dentin thickness is essential as it acts as protective coating against thermal damage. Periodontal tissue damage may occur when the amount of remaining dentine is <1 mm **(Kwon, S. J., Park, Y. J., Jun, S. H., *et al* 2013)**. Therefore, it is imperative to study tooth responses to safeguard the periodontal ligament from high temperatures.

The Wave One file is used in "reciprocal motion' and made from M-wire technology.The M-wire alloy increased flexibility and improves resistance to cyclic fatigue of the instruments[9].The Primary Wave One file used in the present study works at 350 rpm with counter clockwise 170˚C and 50˚C clockwise rotation.WaveOne file is characterized by a modified triangular cross-section with radial lands at the tip and a convex triangular cross-section in the middle and coronal portion of the instrument.The primary WaveOne instruments have a taper of 0.08 over the first 3 mm that decreases to 5.5% **(Al-Hadlaq SM, Aljarbou FA, AlThumairy RI 2010).** The highest temperature increase occur with Wave One file when compared with Neolixneoniti and One Curve file in the present study.This may be attributed to its greater taper and removes less material owing to its modified convex triangular cross-section tip.Hardie reported that the heat generated during the root canal preparation is directly related to the speed of the instruments[1].Hence higher temperature increase with Wave One file may also be attributed to its higher rotational speed. This result is in accordance with the previous study **(Özkoçak, I., Taşkan, M. M., Göktürk, H., *et al* 2015).**

One Curve (Micromega) is recently introduced file made up of C-wire technology.C.Wire is a technique designed, developed and applied by micromega.Controlledmemory,pre-bendable, conservation of the curvature are the characteristics of One curve.The variable cross-section combined with continuous rotation ensures excellent cutting efficiency and a perfectly centered trajectory. It has constant taper of 6% ,works at continuous rotation with 300 rpm. One Curve file showed lower temperature increase when compared to Wave One but greater than NeolixNeoniti.NeoNiTi file is another single-file system, manufactured using Electric Discharge Machining technology, which claims to improve its fatigue resistance, variable changing profiles, progressive flexibility, and results in sharp cutting edges.In the present study Neoniti A1 with 6% taper was used.The Electronic Discharge Machining technology makes the file more flexibile and resistant to cyclic fatigue. NeolixNeoniti showed lowest temperature increase. This may be attributed to its greater flexibility.Gokturk also reported that the heat generated is also directly proportional to

the frictional contact with the canal walls **(Gokturk, H., Ozkocak, I., Taskan, M. *et al* 2015).**Neolixneoniti rotary files showed least heat generation. This may be due to the off centered rectangular cross section and asymmetric "Swaggering" rotation. These features gives the file a snake-like "swaggering" movement as it moves through the canal and results in optimization of root canal tracking as only two points of the rectangular cross section touch the canal wall at a time.

8. Conclusion

The present study showed significant difference between Wave One, Neolixneoniti and One curve file. Wave One file showed the highest temperature increase and Neolixneoniti showed the lowest temperature increase. Hence within the limitations of the study it can be concluded that NeolixNiTi file is safer than Wave One and One curve single file sytems in context of temperature rise in the external root surface.

9. Limitation

The present study was conducted using an extraoral environment. Thus, it was impossible to properly simulate the intraoral environment, and its periodontal status. The results may be different for data obtained in an actual patient because periodontal and osseous blood circulation may influence the heat increases. Thus, further clinical studies are required to assess both the reciprocal and conventional root canal instruments for their potential risk factors.

References (APA)

1. Al-Hadlaq SM, Aljarbou FA, AlThumairyRI(2010). Evaluation of cyclic flexural fatigue of M-wire nickel-titanium rotary instruments. J Endod;36:305-7.
2. Eriksson, A. R., &Albrektsson, T. (1983). Temperature threshold levels for heat-induced bone tissue injury: a vital-microscopic study in the rabbit.J Prosthet Dent, 50(1), 101-107.
3. Eriksson, A., Albrektsson, T., Grane, B., & McQueen, D. (1982). Thermal injury to bone: a vital-microscopic description of heat effects. Int J Oral Surg, 11(2), 115-121.
4. Eriksson, R. A., &Albrektsson, T. (1984). The effect of heat on bone regeneration: an experimental study in the rabbit using the bone growth chamber. J Oral MaxillofacSurg, 42(11), 705-711.
5. Eriksson, J. H., &Sundström, F. (1983). Temperature rise during root canal preparation—a possible cause of damage to tooth and periodontal tissue. Swed Dent J, 8(5), 217-223.
6. Gokturk, H., Ozkocak, I., Taskan, M. M., Aytac, F., &Karaarslan, E. S. (2015). In vitro evaluation of temperature rise during different post space preparations. Eur J Dent, 9(4), 535.
7. Hardie, EM. (1987). Further studies on heat generation during obturation techniques involving thermally softened gutta- percha. Int Endod J, *20*(3), 122-127.
8. Kim HC, Kwak SW, Cheung GS, Ko DH, Chung SM, Lee W(2012). Cyclic fatigue and torsional resistance of two new nickel-titanium instruments used in reciprocation motion: Reciproc versus WaveOne. J Endod;38:541-4.
9. Kwon, S. J., Park, Y. J., Jun, S. H., Ahn, J. S., Lee, I. B., Cho, B. H., &Seo, D. G. (2013). Thermal irritation of teeth during dental treatment procedures. Restor Dent Endod, *38*(3), 105-112.
10. Mc Cullagh, J. J. P., Setchell, D. J., Gulabivala, K., Hussey, D. L., Biagioni, P., Lamey, P. J., & Bailey, G. (2000). A comparison of thermocouple and infrared thermographic analysis of temperature rise on the root surface during the continuous wave of condensation technique. Int EndodJ, *33*(4), 326-332.
11. Özkoçak, I., Taşkan, M. M., Göktürk, H., Aytaç, F., &Karaarslan, E. S. (2015). Temperature increases on the external root surface during endodontic treatment using single file systems. Niger J Clin Pract, 18(5), 678-680.
12. Sauk, J. J., Norris, K., Foster, R. A., Moehring, J.M., &Somerman, M. J. (1988). Expression of heat stress proteins by human periodontal ligament cells. J OralPatholMed, 17(9- 10), 496-498.