An evaluation of temperature rise inside pulp chamber of the tooth during dentin channel preparation by twist drill (A Comparative Study)

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Abstract:

The purpose of this investigation was to evaluate the temperature rise inside pulp during dentin channel preparation by twist drills.

Twenty premolar tooth divided into two groups, each subdivided into 4 subgroup, group a prepared the channels at 1.500 rpm/700 G by first & 5th uses of the drill, group B prepared the channels at 30.000 rpm/50 G measuring the temperature rise inside the pulp, time consumed to prepared each channel.

In both groups there was temperature rise, but in group A (slow speed) the temperature didn't reach to critical level (5.5 °C), while in group B this degree was reached in some of specimen, also found the mean of temperature rise in case of 5th uses drills more higher than the mean of the 1st use in both groups.

Temperature rise inside the pulp during pin-hole preparation affected by speeds, force apply, sharpness of drill and also the diameter and the time consumed.

Keywords:

Temperature, twist drills, premolar tooth, time.

Introduction:

Retentive pins are widely used in restorative dentistry to retain restorations in teeth that have suffered extensive coronal destruction [1].

Pins are placed within most often in vital teeth, and therefore must be sufficiently small so as neither reach the pulp, nor come too close to external tooth surface [2].

There are number of different recommendations in the literatures relating to the rotational speed of twist drill during dentin channel preparation, some workers favors using slow speed [1,2,4], other commented that dentin channel preparation at this speed is extremely difficult and very slow procedure, they recommends using medium speeds [5].

However, potential problems that may result from the use of retentive pin techniques ; perforation into dental pulp and periodontal ligament, a definite craze potentially occur when pins are inserted within 0.5 mm of dentino-enamel junction, weakening amalgam causing reduction in tensile strength and others problems [1,3,4].

Another potential problem associated with the technical procedure of retentive pin has been identified which is heat generation during dentin channel preparation with twist drill [1,3].

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According to the evidence reported, dry cutting can induce sufficiently high thermal stresses and it is enough to cause biologic pulp damage if the cutting is within 1-2 mm from the pulp [6].

It was reported that a 10 °F (5.6 °C) intrapulpal temperature rise up to normal range result in an eventual pulpal death rate of about 40% and an increase of 11.1 °C over normal temperature result in pulp death rate of 60%[7].

Also various alteration can occur by heat generation such as tissue burning, development of reparative dentin, post operative sensitivity, pulpal necrosis [8].

Investigations show that many factors are responsible for heat generation during dentin channel preparation, such as twist drill diameter, depth of channel, rotational speed, dentist variability [1].

It was shown that preparation technique, sharpness of the drill, hand piece torque, duration and frequency of the cutting also will affect on temperature rise inside pulp chamber[9].

So the aim of study is to access and compare in vitro the effect of using two different diameters of twist drills of self threading pins on temperature rise inside the pulp chamber during dentin channel preparation using two variants speeds on first and 5th uses of twist drill under application of a constant load on hand piece.

Material and methods::

Newly extracted human maxillary premolar of a single root, free from caries and restorations was selected for this study, stored in deionized distilled water until ready for testing. The coronal portion 3mm of all teeth removed with a diamond wheel bur using turbine hand piece under a constant water flow.

To make an access of the pulp chamber 3-4 mm of the root cut-off, pulpal content discarded by using endodontic instrument (#20-60). The exact position of the (heat sensor) inside pulp chamber checked by radiographical film for each sample.

In order to exert a constant force on hand piece during channel preparation, used a compression spring balance (Hanson / Irland) with rubber stud that fixed below the table of the balance. In order to stimulate the *in vivo* study as much as possible, the tooth adjusted on a plastic collar that allow no movement of the tooth during dentin channel preparation, this collar embedded within a base of cold cure acrylic resin which then immersed inside glass container that filled by 37 °C water that checked continuously by alcoholic thermometer inside the glass, the level of the water should be with the level of cemento-enamel junction of the tooth.

The (W & H Straight hand piece) connected to a micrometer cable driven (MF-Tectore / W. & H./Austria) driven at desirable speed (1.500 - 30.000 rpm), the hand piece mounted on the handle of (Ney) survey or in order to prepare the channel perpendicular on the occlusal surface.

Four dentin channel done on each teeth, 1 mm inside the dentino-enamel junction, away from each other by 2 mm, the first two channel done on the foundation of a missing buccal cusp at right & left sides, and the second two channel done on the foundation of palatal missing cusp at right & left sides.

The twenty extracted premolars divided randomly into two groups, group A the channel prepared at (1.500 rpm / 700G) twist drill (0.68 mm, 0.53 mm

QD). New twist drill (0.86 mm) used to prepared the channel at right side of the buccal cusp, while the channel at the left side done by 5th uses of the same twist drill. The same procedure but at (30.000 rpm speed/ 50G force).

The time consumed to prepare each channel measured by using digital electronic timer in seconds.

The base line temperature Tb recorded for each sample before preparing each channel, this is done by using digital thermometer (Al-Duhaa-Iraq) connected to the heat sensor inside the pulp chamber, also the peak temperature rise Tp inside the pulp chamber due to channel preparation recorded. From these two different temperatures (Tp, Tb) the heat generation due to channel preparation can be recorded easily TA =Tp–Tb.

Result:

The results obtained from the study as a mean of temperature rise inside pulp chamber during channel 2mm depth preparation with the mean of the time need to reach this depth was illustrated in table 1 for group A (1.500 rpm/700 G) & table II for group B (30.000 rpm/50 G).

The higher temperature rise in case of subgroup A1 was 1.3 °C, longer time need to reach 2mm depth of channel was 8 sec.; in case of subgroup A2 (2.7 °C/10 sec.).

The higher temperature rise in case of subgroup B1 was 3.1 °C, longer time need to reach 2mm depth of channel was 4 sec.; In case of subgroup B2 (5.9 °C/6 sec.), subgroup B3 (2.7 °C/4 sec.), subgroup B4 as in figure (1).

Table (1) : Mean ΔT Temp./ Time group A

Mean	A1 New drill 0.68 mm	A2 5th uses 0.68 mm	A3 New drill 0.53 mm	A4 5th uses 0.53 mm
Base line Tmp. (Tb)	35.19	35.44	35.33	35.49
Peak Tmp. (Tp)	35.81	36.89	35.96	37.07
Temp. rise (ΔT)	0.62	1.45	0.63	1.58
Time (Sec.)	5.3	6.4	5.5	6.6

Table (2) : Mean ΔT Temp., Time group B

Mean	B1 New drill 0.68 mm	B2 5th uses 0.68 mm	B3 New drill 0.53 mm	B4 5th uses 0.53 mm
Base line Temp. (Tb)	35.18	35.42	35.31	35.56
Peak Temp. (Tp)	37.13	39.4	37.3	39.04
Temp. rise (ΔT)	1.95	3.98	1.99	3.48
Time (Sec.)	2.5	4.1	2.8	3.3

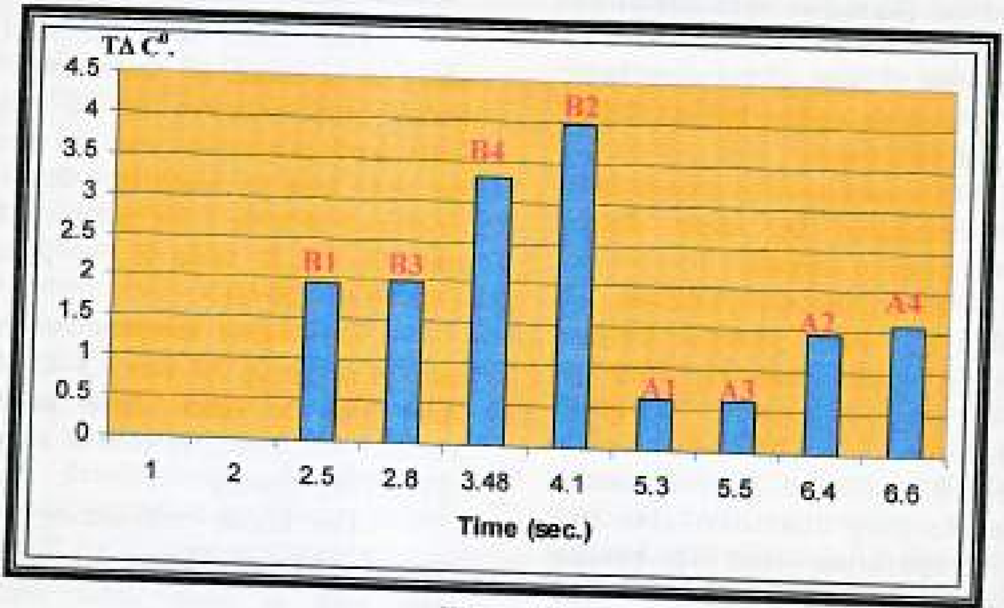

Figure (1)

Discussion:

Twist drills are designed to prepare small channels to receive retentive pins, effective cooling at the bur-tooth interface is precluded by the channel-type preparation resulting in a rise in temperature in this area.

This study indicates that pin channel preparation with twist drill has the potential to produce a temperature increase in the pulp chamber that agree with[1]. This is demonstrated by the mean temperature rise that range between (0.62 °C) the lower mean for the (0.68 mm new drill) and (3.98 °C) the higher one for (0.68 mm 5th uses drill), although the higher mean of the temperature rise doesn't reach the critical degree (5.5 °C), but this study in some instance the temperature rise reached above or very close to it (5.4 C, 5.8, 5.9) which is about 30% in subgroup B2, and 20% in subgroup B4. Seen that temperature rise doesn't reach 5.5 °C when channel prepared at slow speed (1.500 rpm) high load (700 G) in both new or 5th uses of twist drill, or when prepared the channel by new drill at medium speed (30.000 rpm) low load (50G) ; but it is confined just in group B2, B4 where preparation done by medium speed, low load and by twist drills uses 4th time before that, this increase in temperature may be related to the dulling action that occur to the drill which increase the function leading to increase in heat generation which agrees with [10] reported that multiple uses of twist drill will be enhanced in further heat generation & the temperature rise will reach the critical value 5.5 °C at 5th uses of the twist drills.

The findings of this study agree with that of [1] in relating to the diameter of the drill, that the smaller drill (0.53) produce heat generation more than that of larger one (0.68 mm), under the same force exert on the hand piece, this phenomena can be explained depending on the formula designed by [11].

$$\text{Pressure} = \frac{\text{F(force)}}{\text{A(area)}}$$

So that as the diameter of the drill become small the pressure that exert become large which increases the friction of lead to more heat generation, except of these occur between subgroups B2 (5th uses 0, 68 mm drill) and B4 (5th uses 0, 53 drill) where the temperature rise in B2 become more than that of B4. In this case the time consumed (duration of cutting) play a very important role in the explanation of the situation and agree with [6,12] that reported as much as time consuming in cutting procedures as much as heat generation occur inside the pulp chamber.

From this study, various factors may be responsible for heat generation during pin channel preparations, speed, diameter of drill, load applied, sharpness of drill, and the time consumed, the results reported from a laboratory study without any of the biologic factors that may influence heat dissipation, in vivo blood flow through the pulp tissue may help control increase in temperature during pin channel preparation by dissipation of the heat.

References:

1.Robert L. Wayne W. Temperature rise in the pulp chamber caused by twist drills, J. Prosthet. Dent 1980 ; 44:426-9.

2.Caputo A. Standlee P. Pins and Posts - why, where and how ?. Dent. Clin. North Am. 1976 ; 20 :299-311.

3.Bione M. & Wilson R. The effect of the mismatch between the core diameter of self-threading dentin pins and the pin hole diameter. Aust Dent. J. 1998 ; 43: 181-187.

4.Sturdevant M. Pin retained amalgam restorations, art and science of operative dentistry 1995 ; 3rd ed. Ch15 :505-532.

5.Sanja S, Suzana F, Irica A, Silvana J. Changes in dentin after insertion of self-threading titanium pins with 3 methods : a scanning electron microscope pilot study. J. Prosthet Dent. 2002 ; 87:182-188.

6.Wayne W. David E. Robert L. The two-in-one self-threading, self-shearing pin: efficacy of insertion technique. J. Am. Dent. Assoc. 1978 ; 97 :51-53.

7.Zach & Cohen G. Pulp response to externally applied heat. Oral Surg. Med. Path. 1965 ; 19:515-30.

8. Hilding N. Martin B. Pulp reaction to heat. J. Prosthet Dent. 1968; 19:602-612.

9. Watson F. Flanagan D. Stone D. High and low torque hand pieces : cutting dynamics, enamel cracking and tooth temperature . Brit. Dent. J. 2000; 188:680-686.

10.Ulusoy N. Denli N. Atakul F. Nayyar A. Thermal response to multiple use of twist drill. J. Prosthet Dent. 1992 ; 67 :450-453.

11.Morisson A. Grinnell H. The theoretical and functional evaluation of higer speed rotary instrument. J. Prosthet Dent. 1958 ; 8: 297-304.

12.Stanley R. Swerdlow H. Reaction of the human pulp to cavity preparation : results produced by eight different operative grinding techniques. J. Am. Dent. Assoc. 1959 ; 58 : 49-59.