Elevation in surface temperature of root canals obturated with different thermoplasticized gutta-percha obturation techniques-an in vitro study

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ABSTRACT

Background: Many studies have been conducted to evaluate the effect of using a hot material in the root canal and its potential for causing damage to the tooth supporting structure.
Materials and methods: thirty permanent premolars were obturated with thermoplasticized Gutta-Percha using three different obturation techniques: soft core, Thermafil, and obtura to evaluate the rise in temperature on the root surface using a multipurpose digital thermometer.
Results: temperature increases was significantly greater for Obtura versus Soft core ($p<0.003$), not significant for Thermafil versus Soft core ($p<0.087$), and Thermafil versus Obtura ($p<0.125$).
Conclusions: temperatures rise on the root surface were below the critical level and, therefore, should not cause damage to the periodontal ligament.
Key words: Root surface temperature, thermoplasticized gutta-percha. **(J Bagh Coll Dentistry 2014; 26(1):67-70).**

INTRODUCTION

Endodontic therapy aims for complete debridement of pulpal tissues, total obturation of the root canal space, resulting in an inflammatory-free state.[1] The complexity of the root canal system is well documented with fins, lateral and accessory canals, apical deltas, and isthmuses.[2-4] For these reasons, it is difficult to shape the canals to a form that can easily be filled in all dimensions.

One of the materials commonly used for root canal obturation is gutta-percha. Its physical properties have made several different root-filling techniques possible. [5] Many techniques have been developed for placing dental Gutta-Percha as an obturation material. Thermoplasticized obturation techniques were introduced to improve the homogeneity and surface adaptation of gutta-percha. Thermafil which was introduced by Johnson [6] in 1978 was one of these techniques, It involved the use of a carrier coated with a layer of gutta-percha, which, when heated, permits thermoplasticized canal obturation. This system is commercially available as Thermafil Endodontic Obturators (Tulsa Dental Products, Tulsa, OK). Thermafil obturators, with their carriers are coated with α-phase gutta-percha and become part of the final obturation. The manufacturer recommends that the carriers be heated in a special oven, the ThermaPrep Oven (Tulsa Dental Products), before being inserted in a canal previously lined with sealer.[7]

There is a similar technique of root canal obturation known as Soft-Core (CMS-Dental Aps, Denmark). As in the Thermafil system, Soft-Core obturators are heated in a special heater called a Soft- Core Oven (CMS-Dental Aps) and then introduced into the root canal to the working length. Unlike the Thermafil obturator, a single unit, the Soft-Core obturator consists of two parts: a plastic handle with a metal insertion pin, and a plastic core with gutta-percha. The metal pin is not permanently attached to the plastic core; when the obturator is introduced into the canal, the handle is twisted and then removed together with the metal pin.[8]

High-temperature thermoplasticized injectable gutta-percha system (Obtura II, Obtura Spartan, Fenton, MO) was another thermoplasticized gutta-percha obturation method in which the gutta-percha was heated to a temperature of a minimum of (160°C), once plasticized, the gutta-percha is injected through the silver needles into the prepared root canal.[9]

Even though tooth root tissues are poor thermal conductors [10,11], the canal filling with heated gutta-percha may be responsible for the rise of the root outer surface temperature.[12-16] Eriksson and Albrektsson [17] conducted a vital-microscopic study on temperature threshold levels for heat-induced bone tissue injury on rabbit. They found that bone tissue heating to 47°C for 1 min caused bone remodeling and fat cell necrosis.

Other in vivo study by Gutmann et al.[18] in a mongrel dog showed no apparent periodontal tissues destruction after the injection of high-temperature thermoplasticized gutta-percha (Obtura, 160°C) into the root canal. In the study

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cited, the changes in the temperature of the external surface of the bone overlying the roots obturated with thermoplasticized gutta-percha were also recorded and the maximum temperature elevation over 60s was found to be 1.1°C. In another in vivo study, Molywdas et al.[19] used two beagle dogs to assess periodontal reactions after root canal filling with the same system. The obturation with gutta-percha heated to 160°C caused an inflammatory reaction and destruction of collagen fibers in the area around the apical foramen. The alveolar founding bone, the roots of the teeth and the periodontal ligament at the side of the root surfaces remained normal. During the obturation procedure no temperature measurements were taken in the periodontal ligament or on the bone overlying the roots.

The aim of this in vitro study was to measure with infrared thermography temperature changes on the outer root surfaces of maxillary and mandibular single rooted permanent premolars when obturated with thermoplasticized gutta-percha (Thermafil, soft core and Obtura II).

MATERIALS AND METHODS

Teeth collection

Thirty permanent premolars which were extracted for orthodontic reasons were used in this study; each tooth should have a straight single root of 10-12mm length from the cement-enamel junction to the clinical apex. The collected teeth were stored in 5% thymol solution. [20]

Instrumentation

The crown of each tooth was sectioned at the level of the cemento-enamel junction so that the length of each root was about 10-12mm. the working length was estimated by using size 10 reamer which was inserted into each canal until it project from the apical foramen then 0.5mm was subtracted from the estimated length. After the working length estimation of each root, instrumentation was performed using ProTaper hand instruments, according to the manufacturer´s recommendations; instrumentation was started with size (SX) to widen the coronal orifice of the canal followed by size (S1), (S2), (F1), (F2), (F3), (F4), up to size (F5). The canals were irrigated with distil water solution before shifting from one size to another. [21]

Obturation

The thirty prepared canals were divided randomly into three groups;

The first group obturated with injectable thermoplasticized gutta-percha (obtura). Obtura unit was set to the maximum temperature and the gutta- percha was heated up to 199^{o}C. A 23-guage injection needle tip was inserted into the canal 3-5mm shorter than the working length as recommended by the manufacturers, then the softened material was injected into the canal until slight back pressure is felt then the needle was withdrawn slowly until the whole canal was obturated. [9]

The second group obturated with Thermafil obturators; a size 50 verifier was used to check the size of the canal prior to the use of the corresponding obturator. The selected cone was heated in thermaPrep oven (Tulsa Dental Products), the time required and the temperature to which the cones were heated was predetermined in the oven by the manufacturers. The warmed obturators were slowly inserted into the canals up to the working length. [7]

The third group obturated using soft core obturation technique; the canals were obturated in the same manner as described in the second group except that the obturators were thermoplasticized in the soft core special oven (CMS-Dental Aps). Each one of the three groups obturated according to manufacturer's recommendations of each system. No sealer was used during obturation of the three groups to eliminate the possible discrepancies associated with the use of different sealer coating methods with each obturation techniques. [8]

In order to record the rise in temperature over the surface of the thirty root canals a multipurpose digital thermometer that uses infra-red point for measuring the changes in the temperature over the surface of any object that faces its eye. The thermometer was mounted so that the infra-red lens was perpendicular on the mesial aspect of each root 5mm higher than the root apex and at 5mm away from the root surface as recommended by the manufacturers. The rise in temperature over the root surface during and after obturation was measured; readings were taken at six different time intervals (5, 20, 30, 60,120, and 180 seconds). [22]

The collected data were analyzed with NOVA test then LSD test. A difference was accepted as significant for $p < 0.05$.

RESULTS

The mean temperature rises, and SD recorded on the outer root surfaces during and after root canal obturation using all studied techniques are shown in figure 1.and Table 1. The ANOVA and LSD analyses indicated significantly greater temperature increases for Obtura versus Soft core ($p<0.003$), non significant temperature rise for Thermafil versus Soft core ($p<0.087$), and Thermafil versus Obtura ($p<0.125$).

Table 1: The mean temperature rises on the outer root surfaces during and after root canal

	Starting Temp.	During obturation	10sec.	20sec	30sec.	60sec.	120sec.	180sec.
Obtura	25.46	27.72	28.71	28.61	28.51	28.11	27.56	27.13
n=10	0.66	1.02	1.15	1.11	1.02	0.77	0.66	0.90
Thermafil	24.48	25.30	27.15	27.52	27.78	28.10	27.70	26.92
n=10	0.74	1.25	1.83	1.87	1.88	1.49	0.91	0.85
Soft core	24.50	25.20	26.35	26.55	26.65	26.65	25.97	25.37
n=10	0.86	0.77	1.15	1.30	1.31	1.18	0.88	0.73

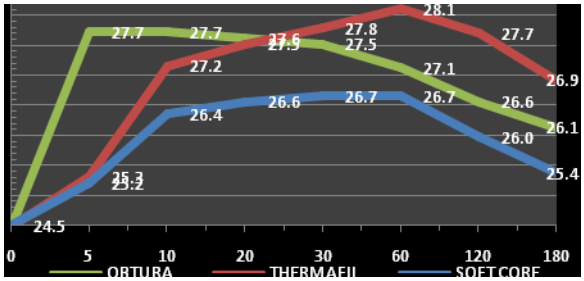

Figure 1. The mean temperature rises on the outer root surfaces during and after root canal obturation

DISCUSSION

Under the circumstances of this study, obturation with Thermafil (115°C) produced the maximum elevation in surface temperature (3.6°C) this rise in temperature took place after 60 seconds from the time of obturators insertion into the canal, this rise in temperature come in agreement with the findings of Lipski et al [23], they used an infrared camera to found in vitro that Thermafil obturation technique produced temperature rises ranging from 2.1°C to 6.1°C with the highest rise take place within the first 10 seconds after cone insertion. On the opposite of the findings of Lipski et al, in this study soft core (115°C) produced the lowest rise in surface temperature as compared to the other two obturation techniques. High temperature injectable gutta-percha (200°C) produced more rapid but lower increase of root surface temperature than Thermafil obturation technique (3.2°C within 5 seconds). Unlike the results of this study Weller and Koch who investigated, in vitro, the radicular temperatures produced by injectable thermoplasticized gutta-percha found that the injectable thermoplasticized gutta-percha when injected at 200°C produced higher increase of temperature at the radicular root surface (3.67°C). [24]

It is generally accepted that a 10°C rise in temperature on the root surface, to approximately 47°C, is considered damaging . [17] At this temperature, damage to the attachment apparatus of the tooth may occur. The present investigation shows that none of the three obturation techniques produced surface temperatures up to the critical level. Several factors may account for this result. First, dentine is a poor thermal conductor and its conductivity varies with its thickness at the different areas of the tooth. [25] There was an almost instantaneous decrease in the temperature of the gutta-percha as it contacted the canal wall and very little heat dissipated across the dentine to the root surface. This temperature decrease may be even more pronounced in vivo because of the fluid present in the dentinal tubules and the circulation present in the periodontal ligament. Finally, there was no prolonged heating of the root by any of the obturation techniques. The study by Eriksson & Albrektsson in 1983 reported that it was necessary to maintain the elevated temperature of 47°C for an extended period for damage to occur. Additional factors may also affect the root surface temperature. The diameter of the root canal itself or the thickness of the remaining dentine may be important. A root canal sealer was not used when obturating the tooth in this investigation. Barkhordar et al in 1990 and Hardie in 1987 reported that the use of a root canal sealer lowered the surface temperature approximately 1-2°C compared with obturations without a sealer. The sealer layer may act as an insulator on the dentinal wall and may help protect the surrounding tissues. The results indicate that within the design of this investigation

the temperatures on the root surface were below the critical level and therefore should not cause damage to the periodontal ligament.

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