CONTINUOUS WAVE TECHNIQUE: TEMPERATURE CHANGES IN DIFFERENT PARTS OF THE TOOTH ROOT

RELEVANCE

Up-to-date endodontic treatment is a high-end technological procedure. Thanks to scientific studies, material and economic base perfection in last decade the paradigm of endodontic treatment has been changed: the main conditions of it are three-dimensional cleaning and obturation of a root canal system.1,16 To provide the successful solution of this task new methods of root canal filling are invented, existing ones are modified.3,14 Improvement of technology of warm vertical compaction (condensation) of gutta-percha led to the invention of the special devices and protocols – thermopluggers and the “continuous wave” technique.2 Modern thermoplugger – is an electronic device with a plugger-shaped working end. It can be used for both heating and compacting gutta-percha in root canal. Commonly in clinical conditions, apical third of a root canal filled using continuous wave, and the middle and cervical thirds are filled with melted gutta-percha with the help of a special injector (extruder). This procedure was named “Hybrid technique”16, 19. Currently, varieties of devices from different manufactures for hybrid obturation are presented at the market (Fig. 1).

Abstract

The study investigated the dynamics of temperature changes on the outer surface of the tooth root during root canal obturation using continuous wave technique. Established the safety of this procedure for periodontal tissues, which allows us to recommend it for use on an everyday dental practice.

KEYWORDS: Endodontic treatment, root canal obturation, gutta-percha, down-pack plugger, continuous wave technique.

Fig. 1. Up-to-dated electronic devices for root canal obturation with warm gutta-percha using the continuous wave technique:
Endodontics

For surrounding tissues.

A.R.Eriksson and T.Albrektsson,4 E.M.Hardie 8 assert, that 5 minutes leads to bone resorption and replacing of missing structures with a temperature of 50°C during 1 minute or at a temperature of 47°C during to destruction of the last. Authors also showed that heating bone tissues at alkaline phosphatase inactivation takes place in bone tissues, which leads alteration in bone tissues can be noticed after increasing the temperature on the external surface of the root up to 44-47°C during 1 minute. At the same time, D.L.Husseyet et al.10 and M.Lipski 11 proved, that short-term influence of high temperatures on tooth and periodontal tissues during filling root canal using continuous wave technique with modern electronic thermoplugger.

MATERIALS AND METHODS

The aim of the study is to look into the temperature changes, taking place in tooth and periodontal tissues during root canal filling using continuous wave technique.

A range of factors can explain the state of affairs: from the lack of material and technical support of dental clinics to low level of theoretical and practical dentist’s training.5,9,13,14 A vagueness of a number of aspects of clinical usage of vertical gutta-percha compacting plays an important role. Many dentists consider this method dangerous for periodontal tissues due to high temperature (200-300°C), used during vertical gutta-percha condensation, that has a number of disadvantages. The main of them are non-homogenous canal filling, thick layer of sealer between posts, and a high risk of vertical root fracture.6,12,16

Despite the fact, that technique of three-dimensional root canal filling using thermoplastic gutta-percha exists more, than a decade,1,18,23 there is no well-defined opinion about safe limits of heating and arising in tooth, periodontal tissues and in alveolar bone during filling root canal with warm gutta-percha, taking into account permissible limits of heating and constructional features of modern endodontic devices and instruments.

THE AIM OF THE STUDY

The study involved 20 intact single-canal premolars, extracted due to orthodontic prescriptions. Tooth were picked out not later than 15 minutes after extraction, cleaned and placed into +4°C distilled water for not more, than 10 days.

After creating endo access, premolar root canals were proceed by a standard protocol. Canal was navigated using steel K-files #10; glide-path was created using rotary nickel-titanium instruments “PathFile” (Dentsply). On this stage tooth canals were shaped till ISO size 19. To shape the canals, rotary NiTi instruments «ProTaper» (Dentsply) until F2 file size (working end tip diameter – 25 ISO). Current and finishing irrigation was provided by 3% solution of sodium hypochlorite («Parcan», Septodont) using passive ultrasonic activation.

As a completion, root canals were irrigated using 10ml of distilled water and dried with paper points. The «GuttaEst-V (L)» (GeoSoft Dent) device was used during laboratory investigation of temperature changes in tooth tissues during canal filling using continuous wave technique. After tooth canal preparation, a thermoplugger was fitted. Working end size was selected to be wedged 5mm before apical foramen (fig. 2). F2 size gutta-percha post was fitted on a working length (fig. 2, bl).

A. Behnia and N.J.McDonald2 ascertained, that at a temperature of 56°C alkaline phosphatase inactivation takes place in bone tissues, which leads to destruction of the last. Authors also showed that heating bone tissues at a temperature of 50°C during 1 minute or at a temperature of 47°C during 5 minutes leads to bone resorption and replacing of missing structures with adipose tissues. A.R.Eriksson and T.Albrektsson,4 E.M.Hardie6 assert, that alteration in bone tissues can be noticed after increasing the temperature on the external surface of the root up to 44-47°C during 1 minute. At the same time, D.L.Husseyet et al.15 and M.Lipski21 proved, that short-term temperature increasing on an external surface of the root by 10 10°C is safe for surrounding tissues.
Fig. 2. Preparation of the laboratory’s tooth root canal for filling (sketch):

a – plugger fitting (WL - 5 mm);

b – fitting gutta-percha post till WL.

K-type thermocouples (chromel/alumel) with a sensor size of 0.5mm were installed in predetermined points of the tooth. They were connected to the computer using UT323 (UNI-T) thermometer (Fig. 3). For the simplicity of text perception by dentists without engineering education, the authors consider rational to replace the term “K-type thermocouple” by the term “thermo sensor”.

Fig. 3. Elementary diagram of the laboratory investigation.

Two thermo sensors (N1, N2) were installed on an external surface of the root at a distance of 8 and 5 mm from tooth apex. For the third thermo sensor, a tiny canal was burred at a distance of 3mm from the apex to record temperature changes in gutta-percha post. Thermo sensor #4 was installed in the area of tooth apical foramen (fig. 4).

The fitted gutta-percha post with sealer «AH Plus» (Dentsply) was immersed into the root canal. The system with tooth and thermo sensor was placed into a thermostat with warm water (+37°C). After that canal was filled using continuous wave technique according to the generally accepted rules\(^1\) using thermoplugger «GuttaEst-V (LI)» (GeoSoft Dent). The temperature was set to 200°C. The tip of the thermoplugger was placed on the canal opening, then heating was activated and the instrument was forwarded through gutta-percha with one movement on a level 3mm shorter, than determined length (fig. 5, a). After that heating was switched off and, keeping apical pressure, instrument tip was forwarded down to determined point (fig. 5, b). Reaching determined point, apical pressure on a plugger was kept during 10 more seconds to compensate cooling gutta-percha shrinkage (fig. 5, c). After that, plugger was removed with gutta-percha remains (fig. 5, d). Output data from thermo sensors were captured using special software.

Fig. 4. Scheme of thermo sensors positions in under study tooth.

Fig. 5. Scheme of root canal filling using continuous wave technique during laboratory investigation:

a – inputting warm plugger into the root canal;

b – immersing plugger and compacting gutta-percha in the apical direction with the instrument heater off;
c – reaching preset work length of a plugger immersing with a constant apical pressure on an instrument;

d – excretion of the plugger with gutta-percha remains.

Clinical part of investigation took place on a basis of dental clinic «MAH» (city Bryansk). Efficiency, ergonomic, specifications and clinically important characteristics and method of application of «GuttaEst-V (LI) » (GeoSoft Dent) device were assessed.

RESULTS AND DISCUSSION

Temperature change dynamic in different tooth parts can be found on figure 6. Data, collected during laboratory investigation, shows us, that maximal temperature increase on the external surface of the root during filling process was found 8mm before apex and equaled +3,8±0,6°C. Thus gutta-percha was heated up to 109,2°C. Gutta-percha can be heated and compacted without chemical structure changes.

![Fig. 6. Temperature change dynamic in different tooth root parts during filling using continuous wave technique in laboratory conditions.](image)

It is interesting to note, that switching thermoplugger multiple times inside tooth canal does not lead to serious temperature increasing on the external surface of the root (fig. 7). We have found out, that tenfold thermoplugger switching on leads to stabilization of the temperature at the level of +41,3±0,4°C. After that, a long period of tooth tissues cooling down follows: after single switching on tooth cools down in 16±3 seconds, after tenfold – in 35±6 sec.

![Fig. 7. Temperature change dynamic in different tooth root parts in laboratory conditions with one fold and tenfold thermoplugger switching on.](image)

Accumulated data shows us, that temperature increasing on the external surface of the root during root canal filling using continuous wave technique with modern electronic thermopluggers with standard temperature mode is perfectly acceptable and safe for the surrounding tissues.

Root canal filling technique involving thermoplugger (continuous wave technique) allows us to ensure fast (on average, 12-15 sec) obturation of 5mm of apical part of the root canal, solving the main endodontic problem of classical Schilders vertical compaction: decreasing procedure’s length and complicity. In English publications, this stage is named Down-pack.

As soon, as apical part of root canal is filled, a method of filling the rest of the canal is to be chosen.

If it is planned to place fiber post, metal screw post or cast pin-stump construction, it is not required to fill the rest of the canal with gutta-percha.

If the canal requires complete filling, then two options exist. The first one – using thermoplugger, according to above-described technique. The only difference is the temperature mode: in this case, the temperature of +100°C is used. However, this option is laborious, gutta-percha posts may stick to the plugger at this temperature, therefore majority of dentists prefer to use injection of warm gutta-percha. Using this technique the middle and cervical part of the root canal are filled with warm gutta-percha using special injector (extruder) (fig. 8) with portions of 3-5 mm, compacting them using cold manual plugger. In English literature, this technique is called Back-Fill.

![Fig. 8. Extruder for injection root canal filling with warm gutta-percha «GuttaFill» (GeoSoft Dent).](image)

CONCLUSION

According to the results of laboratory investigation, and our clinical experience (Fig. 8, 10), filling root canals using continuous wave technique with modern
endodontic devices is safe and effective. Apprehensions of possible thermal trauma of periodontal and bone tissues are considered groundless. A wide application of continuous wave root filling technique in practical dentistry is highly recommended.


More References are available on request.