The adaptability of three different gutta percha obturation techniques: Thermafil, System-B/Obtura, lateral condensation.

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ABSTRACT

Background: Complete obturation of the root canal with an inert filling material and creation of a hermetic apical and coronal seal are the goals of successful endodontic treatment. The aim of the study was to evaluate and compare the adaptability of gutta percha root canal fillings achieved with Thermafil, system B/Obtura, and lateral condensation techniques.

Materials and methods: Forty five freshly extracted maxillary first molar teeth were selected for this study. The canals were prepared with crown-down technique using GT rotary files; the coronal half of the roots were instrumented using ISO 12/35 GT rotary file at 300-350 r.p.m. The apical half was instrumented with ISO 04/30 GT rotary file, and for shaping the most apical third of the canal they were prepared with No. 35 reamer by reaming action only. The prepared roots were obturated using either Thermafil system (G1): using System B/ Obtura technique (G2) or Lateral condensation technique. The teeth were sectioned horizontally 1.5 mm occlusal to the true anatomical apex. The next four sections were made so the occlusal surface was 4.0, 6.0, 8.0, and 10 mm occlusal to the anatomical apex. The samples were examined under a light optical microscope to trace the periphery of each area in the image to calculate: Sealer/Gutta percha ratio, Sealer film average thickness and the percentage of increase above sealer average film thickness.

Results and conclusion: At the apical two levels Lateral Condensation obturation technique had the best adaptability to canal walls followed by Thermafil and finally by Obtura/System-B technique, while at the coronal three levels Obtura/System-B obturation technique had the best adaptability to canal walls followed by Thermalfi and finally by Lateral Condensation.

Keywords: Thermafil, Obtura/System-B, Lateral condensation, adaptation.

INTRODUCTION

Complete obturation of the root canal with an inert filling material and creation of a hermetic apical and coronal seal are the goals of successful endodontic treatment. (1) Most obturation methods make use of a solid core cemented in the root canal with a sealer which plays an important role in the sealing ability of root fillings; without using sealer, root fillings leak. (2,3) The sealer is capable of filling imperfections and increasing the adaptation of gutta-percha. (3) However, previous studies have shown that some endodontic sealers are soluble (4,5) and some may shrink slightly. (6,9) Therefore, for optimal results, the sealer component should be kept to minimum.

Gutta-percha is commonly used with various techniques to enable the dentist to accurately and thoroughly obturate root canal systems. (10-12)

The flexible semisolid condition of gutta-percha cones has permitted root canal obturation, with either a single cone or with several cones used in a cold compaction method. Beatty et al observed that placement of a gutta-percha master cone without condensation into a sealer-filled canal did not reduce the extent of apical dye penetration observed with obturation by sealer alone. With lateral condensation, a series of gutta-percha cones are compressed into the root canal to create a more thorough three-dimensional obturation of the root canal system than might be achieved with other non-compaction techniques. (13)

Using heat to plasticize gutta-percha for root canal obturation was described by Noyes who heated the gutta-percha until it became "as hot and fluid as possible without burning it and churn it into the pulp canals with a hot instrument." (14)

Various techniques have been suggested for root canal obturation with heat plasticized gutta-percha. Schilder demonstrated a technique in which a heat carrier known later as system-B is used to carry heat to soften the gutta-percha within the canal.

Injection-molded thermoplasticized gutta-percha was reported by Yee et al. (15) To plasticize the gutta-percha heating was done so
that the gutta-percha would flow. Marlin reported a clinical use of the injectable warm gutta-percha system (Obtura, Unitek). The technique "could obturate fins, cul-de-sacs, and minute intracanal communications." In obturations with Obtura, Evans and Simon observed that although the thermoplasticized gutta-percha would "penetrate dentinal tubules when the smear layer has been removed, the use of a root canral sealer is necessary to prevent apical leakage in vitro," (17)

Johnson reported the use of a gutta-percha-coated carrier to fill canal that was later produced as the Thermafil System. Such systems consist of a flexible central carrier coated with a layer of α-phase gutta-percha. The device is heated to soften the gutta-percha before insertion into the root canal. (18) The Thermafil system can produce a homogenous mass of gutta-percha in the canal unlike lateral condensation.

Root-sectioning has been used widely to evaluate the quality of root fillings. The methodological model used in this study was introduced by Eguchi et al and thoroughly explored by other authors. (22-27)

The objectives of this study were to evaluate and compare the adaptability of gutta percha root canal fillings achieved with Thermafil, system B/Obtura, and lateral condensation techniques through calculation of (1) Sealer/gutta percha ratio, (2) Average film thickness of sealer and (3) Percentage of increase above sealer average film thickness. All of the above objectives were obtained by means of surface area calculations on stereomicroscopic photographs taken at different apical levels.

MATERIALS AND METHODS

Sampling
Forty five freshly extracted maxillary first molar teeth with straight palatal root canals and mature apices were selected for this study from the clinics of the University of Baghdad, college of Dentistry. The selected teeth were stored in 0.1% Thymol solution at room temperature.

Instrumentation
The palatal roots of teeth were sectioned perpendicular to the long axis of the root at the furcation area, to facilitate straight line access for canal instrumentation and filling procedure. The correct working length was established by subtracting 1mm from this measurement. The canals were prepared with crown-down technique using GT rotary files (Maillefer, Switzerland); the coronal half of the roots were instrumented using ISO 12/35 GT rotary file at 300-350 r.p.m. The apical half was instrumented with ISO 04/30 GT rotary file, and for shaping the most apical third of the canal they were prepared with No. 35 reamer by reaming action only. The canal was irrigated with 5.25% NaOCl between each insertion of rotary instrument and reaming action followed by irrigation with deionized water to avoid development of NaOCl crystals then the roots were dried with paper points.

Canal filling
The prepared roots were obturated using either Thermafil system (G1): using System B/Obtura technique (G2) (28) or Lateral condensation technique. Endodontic sealer was used along with gutta percha (Dorident, Austria).

In G1 (Thermafil system), a size 35 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 (Dentsply). The warmed obturators were slowly inserted into the canals up to the working length and the handle of the carriers were cut at the canal orifice with a high speed bur. The gutta percha, which was still in the thermoplasticized phase, was vertically compacted around the carrier with a hand plugger.

In G2 (System B/Obtura technique) a size 35 master cone (Reoko, Germany) was seated to the full working length. System-B was used according to the manufacturer’s recommendation to make an apical plug against apical extrusion of thermo-softened gutta-percha. The medium-large insert tip which bound in the canal 3mm from the working length, was used to cut the master cone 3mm shorter than the working length. The System-B unit was preset to 200°C during cutting of master cone, and to 100°C during apical condensation of the apical portion of the master cone. The rest of the canal was obturated by means of backfill using Obtura II system. Obtura unit was set to the maximum temperature and the gutta percha was heated up to 190°C. A 23-guage injection needle tip were 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. Immediately after withdrawal of the needle, the warm gutta percha was vertically condensed with a root canal plugger. The excess material was removed with a hot hand instrument.

In G3 (Lateral condensation technique), a size 35 master cone was inserted into the canal to the full working length. The previously checked...
finger spreader is inserted between the master cone and the canal wall using firm (apical only) pressure (1-3 kg) to within 1 to 2 mm from working length. A space for an additional accessory cone was filled by 5 accessory cones. When obturation of teeth was accomplished, the excess gutta-percha was removed with heated instrument to a level 1mm higher than the coronal end of the roots and vertically condensed with root canal plugger so the gutta percha would obturate the entire canal up to the coronal terminus. For complete setting of the materials the filled roots were stored at 100% humidity at 37°C for one week.

Samples sectioning
The first horizontal section was made so that the apical surface was 1.5 mm occlusal to the true anatomical apex. The next four sections were made so the occlusal surface was 4.0, 6.0, 8.0, and 10 mm occlusal to the anatomical apex (Figure 1)

In order to achieve a highly polished surface of the obtained sections that is devoid of scratches and deformities fine sandpaper was used to obtain a highly reflective surfaces.

Data collection
The samples were examined under a light optical microscope (BioVision) and photographed at a 20X magnification. In order to standardize the measurements obtained from each slide, all slides were scaled by means of ocular micrometer ranged from 0.1-10mm; the obtained digital images were edited with ACDSee 9.0 program. AutoCAD program (Autodesk Inc, San Rafael, Calif.) was used to trace the periphery of each area in the image to calculate:

Sealer/Gutta percha ratio.
Sealer film average thickness.
The percentage of increase above sealer average film thickness.

RESULTS
The summary of mean values and the standard deviation of the Sealer/Gutta Percha (S/GP), Sealer Average Film Thickness (SAFT), and the Percentage of Increase above Sealer Average Film Thickness (PISAFT) at each one of the five levels (2, 4, 6, 8, and 10mm) for the three obturation techniques are shown in diagrams below.

Sealer/Gutta percha ratio

![Figure 2: Sealer/gutta percha ratio (S/GP) for different obturation techniques](image)

For sealer/gutta percha ratio (S/GP) the mean values for the different obturation techniques are shown in figure 2. From that figure both the highest and the lowest mean values for sealer/gutta percha ratio were seen at the fifth level of LC group (0.131) and third level of System B/Optura group (0.04). To compare between the differences of the three obturation techniques at each level ANOVA test was performed, high significant different were found at the third, forth, and fifth levels (p<0.000). By performing the LSD test it was shown that the differences at the third, fourth, and fifth levels between obturation groups were mostly significant.

Sealer average film thickness

The least value of sealer average film thickness is seen at the third level of Obtura group (0.04) while the highest value was at fifth level of Lateral Condensation group (0.139) (figure 3). To compare between the three obturation techniques at each level ANOVA test was performed, the differences were significant (0.001<P<0.048) at all levels. LSD test between the groups at each level showed that most of the statistically significant differences occurred between Obtura and Lateral Condensation groups at all levels (0.00<p<0.026), at the third level between Thermafil and Lateral Condensation groups (p<0.017), and at the second level between Thermafil and Obtura (p<0.025).
The adaptability of three different restorative dentistry techniques.

Percentage of increase above sealer average film thickness

Both the highest and the lowest mean values were at the fifth level but for two different obturation techniques (LC, 43; Obtura, 18) (figure 4). To compare the PISAFT between the three obturation techniques at each level ANOVA test was performed. Variable degrees of significance (0.000<p<0.004) were found between obturation techniques at all levels except for the first level. For more statistical information a Least Significant Differences test (LSD) was performed to compare pairs of values of increase above sealer average thickness at each level between the three obturation groups. The results showed that there were statistically significant differences at multiple levels between the three obturation groups that varied in their significance (0.00<p<0.015).

DISCUSSION

The apical two levels

The higher mean values of S/GP for Obtura group at the first level as compared to the second level could be due to the displacement of the apical plug of gutta-percha during the injection of the thermoplasticized material, by the heat received from the hot injected material, the apical plug could be unseated and floated in the injected (molten) gutta-percha during the back filling of the canal. This may come in agreement with the findings of Ritchie et al (30) who evaluated the apical extrusion of Thermoplasticized gutta-percha used as a root canal filling.

The single-penetration method of the preheated Thermafil cone into the canal may act as a piston against which the sealer in pumped towards the apical foramen that would not allow a sufficient exit of the entrapped sealer. This may explain the high S/GP of Thermafil at the first level. In this study the entrapment of the sealer near the apical terminus of the canal may by due to the minimally sized canal at the apical third as compared to other researchers such as Gencoglu et al (26), Jarrett et al (31) who enlarged the canal up to size 60, and De-Deus et al (30) study in which the apical third of the root canals were prepared in balanced force technique with sizes 60, 55, 50, and 45.

The low adaptability of Thermafil as compared to the lateral condensation at the apical third could be caused by the temperature decrease caused by cooling of the thermoplasticized gutta percha which will exhibit a relatively lower viscosity and less ability to adapt to the canal walls when the softened material were introduced at a relatively low insertion rate, this come in agreement with Levitan et al (33) who evaluated the effect of insertion rates on fill length and adaptation of a thermoplasticized gutta-percha technique.

On the other hand, the relatively higher adaptability at the most apical levels of the canal for lateral condensation might be due to the tapered shaped of the canal that would provide an effective matrix in the apical portion against which the gutta-percha can be condensed.

One of the observations of the current study was the high incidence of canal irregularities at the first level that may explain the better adaptability of gutta percha at the second level in all groups than the first level. This observation may co-inside with the findings of Wu & Wesselink (3).

The coronal three levels

The high adaptability of the gutta percha in the Obtura group at the third level may be due to the effect of the vertical condensation applied after the complete obliteration of the canal. The vertical condensation applied towards the third level which is almost 4mm from coronal end of the canal would compact the thermo-softened material through a tapered and increasingly narrower canal. Loads are going to be increased at that level forcing the sealer to escape towards the wider coronal levels.

At the fourth and fifth levels, the relative
increase in SAFT mean values from the third, fourth, to the fifth levels for the two thermoplasticized gutta percha obturation groups (Obtura and Thermafil) could be due to this coronal escape of sealer as a result of vertical condensation.

The behavior of Obtura and Thermafil groups between the coronal three levels was less predictable and more surprising than that of lateral condensation technique. The readings from these levels were fluctuating from one level to another and seldom extended for any distance vertically.

Spreader traces that were one of the common observations in the current study could explain the results of Lateral Condensation group at the coronal three levels which showed that the mean values for S/GP, SAFT, and PISAFT were increasing from one level to the other in a coronal direction. Gound et al in stated that these traces could be due to the use of a fine spreader in conjunction with finer accessory points. (34)

The lack of complete fusion between gutta percha cones and the subsequent increase in the mean values of lateral condensation for S/GP, SAFT, and PISAFT between the coronal three levels in an occlusal direction may be related to the increased taper of that segment of the canal and its reducing effect on the lateral forces applied by the spreader during its penetration inside the canal which will decrease as the canal increase in its diameter occlusally. This comes in agreement with the research of Blum et al (35) who compared the forces developed during three obturation techniques (warm vertical compaction, lateral condensation, and thermomechanical compaction) using a computerized recording system. In their study they confirmed that the deformation of gutta percha is due to the spreader insertion and not to the lateral exerted forces. Unlike Thermafil and Obtura groups, these areas of sealer were frequently continuous from one level to another in an occlusal direction.

To explain the significant differences in the percentage of the increase above average thickness (PISAT) between levels, it’s necessary to understand that this variable depends on the pattern of distribution of both gutta percha and sealer within the cross section of the root canal filling. The inability of gutta percha to form a homogenous mass instead of laminated cones (as in lateral condensation group) around which sealer could be entrapped would make the distribution of sealer around and in between the gutta percha cones irregular rather than as a rim of uniform thickness. This would explain the relatively higher mean values of PISAFT in lateral condensation group than the other two groups at all levels. This also could help to understand the progressive decrease in PISAFT mean values in a coronal direction for Thermafil and Obtura group where the material tend to form a homogenous mass by the effect of vertical condensation.

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Sealer filled area \((S)\) = Total area of the canal - Area of Gutta Percha
Sealer/gutta percha = \(S/GP\)
Sealer average film thickness (SAFT) = \(S/[(D1+D2)/2]\)

Percentage of increase above sealer average film thickness (PIASFT) is calculated by measuring the sealer thickness at randomly arranged thirty six points all around the sealer film.

\[\text{PIASFT} = \frac{\text{No. of points at which the sealer thickness was above average}}{36}\%\]

Figure 5: Calculations of the S/GP, SAFT, and PIASFT.