In vitro evaluation of carrier based obturation technique: a CBCT study

Gianluca Gambarini, MD, DDS
Lucila Piasecki, PhD, DDS
Giovanni Schianchi, DDS
Dario Di Nardo, DDS
Gabriele Miccoli, DDS
Dina Al Sudani, PhD, DDS
Roberto Di Giorgio, DDS
Luca Testarelli, PhD, DDS

1 Department of Oral and Maxillo-Facial Sciences, “Sapienza” University of Rome, Italy
2 Department of Periodontics and Endodontics, University at Buffalo (NY), USA
3 Department of Restorative Dental Sciences, College of Dentistry, King Saud University, Riyadh, Saudi Arabia

Corresponding author:
Lucila Piasecki
Department of Periodontics and Endodontics, University at Buffalo
240 Squire Hall
14214 Buffalo (NY), USA
E-mail: lucilapiasecki@hotmail.com

Summary

Aim. The goal of the study was to compare the ability of two different carrier based obturation (CBO) techniques to reach working length and fill in three-dimensions root canal systems, by using CBCT.

Materials and Methods. Twenty-six extracted molars were scanned with CBCT and 40 curved canals were selected (between 30° and 90°) and divided in two similar groups (n=20). All canals were prepared up to size 25 taper .06 using nickel-titanium instrumentation. The canals in the Group SC were obturated using Soft-Core obturators (Kerr, Romulus, MI, USA), while Group TH canals (n=20) were obturated using Thermafil Endodontic Obturators (Tulsa Dental Products, Tulsa, OK, USA), strictly following manufacturers’ instructions for use. The obturations were analyzed by means of CBCT to measure the distance from the apical limit of obturation to the apical foramen and the presence of voids inside root canals.

Results. There was no significant difference between the two groups in the mean distance of the apical extent of the obturation (t test, p>0.05). Overfilling occurred in only 3 cases (2 in Group TH and 1 in Group SC). The percentages of voids in both groups were very low with no significant difference (Z test, p>0.05).

Conclusions. The two tested CBO techniques showed similar positive results in terms of performance, even if, after checking with verifiers, in most cases the size of the selected Soft-Core obturator was one size smaller than Thermafil.

Key words: endodontic obturation, Thermafil, Soft-Core, Cone-beam Computed Tomography.

Introduction

The success of endodontic therapy is directly related to the sealing of the root canal system, by means of a three-dimensional hermetic endodontic filling (1, 2). The primary objective of the endodontic obturation in root canal treatment is to prevent the ingress of microorganisms or fluids, from both oral cavity or periapical area, and also refrain the growth of any residual bacteria left in the canal system (1-4). An inadequate seal might result in contamination of the canal spaces, thus leading to periapical disease (1, 2, 4). The combination of gutta-percha with a layer of endodontic sealer is the most commonly used material for root canal obturations. A variety of techniques have been developed to provide the proper adaptation of the gutta-percha root canal walls, aiming the complete filling of the root canal system (2, 4). Johnson (5) developed an obturation technique using flexible metal/plastic carriers coated with α-phase gutta-percha (Thermafil Endodontic Obturator, Tulsa Dental Products, Tulsa, OK, USA). The main goal of this carrier based obturation (CBO) technique is to obtain a predictable thermo-plasticization and the consequent flow of the gutta-percha, by using a specific oven with a precise temperature control.

Previous studies have reported a good sealing ability of Thermafil obturations (6-10). The advantages of the carrier-based obturation (CBO) are related to the flow of the gutta-percha inside the root canal space, which is achieved by the combination of the heating process and the fact that the carrier facilitates the insertion of filling material and also slightly pressure it alongside the canal walls. Moreover, the simplicity of the CBO prevents the risks and problems related to the use of spreaders, pluggers, heaters and compactors inside complex root canals. Therefore, different types of CBO have been developed, such as the Soft-Core™ obturators (Kerr, Romulus, MI, USA). Ac-
The Group SC canals (n=20) were obturated using a 10 K-file and dried by paper points. Procedures were completed, all canals were checked for patency with 3 mL of 17% EDTA and saline. After shaping procedures, each instrument using NaOCl 5% and final rinse with Thermafil 18 0.32 (0.24) 2 10% a.

voids.

The teeth of both groups were radiographed in mesiodistal and buccolingual directions and then kept at 100% humidity and 37°C for 1 week, for the setting of the sealer. The post-operative CBCT was taken by using the i-Cat 500 (0.12 mm resolution). The quality of obturation was assessed by an experienced radiologist, using the I-Cat Vision software (Kavo, Biberach an der Riss, Germany). Images were analyzed in the three planes (coronal, transversal and sagittal) to detect visible voids and to check the apical limit of obturation. The number of visible voids were calculated for each canal, while the underfilling was measured by determining the distance (in mm) from the apex to the end of the root canal obturation. The CBCT images were submitted to a rendering process to visualize more clearly any defects of the obturation (voids or underfilling) in the three-dimensional reconstructions. Data was submitted to statistical analysis with significance set at p<0.05.

Results

In three cases a slight overfilling of gutta-percha was observed of the root canals (2 in the Group TH and 1 in for the SC). These cases were excluded for the measurement of the distance between the limit of obturation and the apical foramen (Tab. 1). No significant differences were noted between the mean distances of the groups (t test, p>0.05). Visible voids were detected only in three canals (2 of Group TH and 1 of Group SC) and in only one case more than one void was present inside the canal (Fig. 1). The proportions Z test showed no difference in the percentage of canals with voids between the two groups (p >0.05).

<table>
<thead>
<tr>
<th>Group</th>
<th>Distance</th>
<th>Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Thermofil</td>
<td>18</td>
<td>0.32 a (0.24)</td>
</tr>
<tr>
<td>Soft-Core</td>
<td>19</td>
<td>0.27 a (0.18)</td>
</tr>
</tbody>
</table>

Different superscript letters indicate statistically significant difference within column.
Discussion

Several methods have been proposed to investigate the quality of root canal fillings technique (1, 3, 8, 9, 11-13, 15-17), such as radiographs, bioluminescence, histological sections, dye leakage, microleakage models and clearing techniques. The use of CT or CBCT is a quite recent methodology, which has many advantages: convenience, decreased examination time, lack of removal dentinal tissue, lack of damage of samples, possibility of different plane of examination and different sections of canals, and repeatability. CT is more costly and time consuming, but more precise. CBCT is easier and quicker to perform, and is more similar to clinical imaging. Moreover, the CBCT analysis allowed not only the evaluation of voids, but also the precise measurement of the apical length of the obturation. Although the CBCT images can be more easily visualized by three-dimensional rendering using specific softwares (Fig. 1), this image processing was made as an experimental model to confirm the CBCT findings (Fig. 2).

Results of the present study showed that there was no significant difference between the two tested CBO techniques in the apical extent of the root canal filling. Differently from some previous studies (11, 12), we found that despite the canal curvature, the apical limit of obturation was very satisfactory. Most of canals were sealed very close to the established working length, and a slight overfilling of gutta-percha was recorded in only two Thermafill cases and in a Soft-Core one, but there was no carrier protrusion beyond the apex.

These positive results are clearly related to a proper use of verifiers. Although the root canals were shaped up to a taper .06 and size 25, for the SC group the majority of canals (n=16) were filled with obturator size 20. It was observed that the Soft-Core verifier size 20 was correctly reaching WL while the size 25 verifier was short in those cases. For TH group, 18 all canals were obturated with size 25. This difference between the brands are probably related to their features: the Thermafil obturators present a smaller coronal dimensions and a bigger plastic core, while Soft-Core obturators have a thinner core and a greater amount of gutta-percha. A thinner core could also be related to a denser filling, since a greater gutta-percha ratio is considered preferable in maintaining the long-term apical seal (8, 9).

The apparently mismatch of sizes among the CBO brands proved not to be clinically relevant because the results of both were similar and satisfactory. This might be explained by the fact that in a CBO technique, the obturator is always well plasticized along its entire length. Accordingly, Marciano et al. showed that both Thermafil and System B were more effective than cold condensation techniques in the obturation of roots with isthmuses (9). Therefore, the gutta-percha flows not only apically but also laterally, filling

Figure 1. The CBCT (sagittal plane) and 3D rendering of the same obturated tooth showing the presence of voids (arrows).

Figure 2. Detection of voids (arrow) and measurement of distance between apical foramen and obturation (dashed line), using 3D rendering.
a slightly wider canal space adequately, especially if we have more mass of gutta-percha, likewise in the Soft-Core obturators. Nevertheless, CBO are less effective than other warm obturation techniques in the filling of internal resorptive cavities (15). Moreover a more flexible and smaller size carrier will reach working length with less risk of striping of the gutta-percha (11). Clinicians need only to pay attention at not pushing the carrier beyond the apex, which can be easily achieved by correctly placing the rubber stop on the obturator at the proper working length. Overall, when size 20 was used, Soft-Core obturators reached working length in severely curved canals more easily and predictably than Thermafil size 25. Table 1 shows the mean data concerning the distance between the apical foramen and root canal filling for both techniques.

Likewise, no significant difference in terms of voids and gaps was found between the two techniques, showing the excellent performance of CBO in severe curvatures. The 3D rendering images clearly shows how canals were three-dimensionally filled (Figs. 3, 4). Present results are in agreement with previous researches that also showed no difference in the percentage of canal area filled and voids between Thermafil and Soft-Core (15).

There have been many studies comparing obturation methods in vitro showing the effectiveness and simplicity of CBO techniques (6-10, 15). The findings of the present study confirmed these positive results, with a minimal amount of voids and underfilling. De Moor and Hommez compared different obturation materials with a dye leakage study and found that there were no differences in the long-term sealing ability between Thermafil and Soft-Core (18). A prospective clinical study (19) found no difference in success rates when filling the root canals with Soft-Core or lateral condensation. Another clinical study (20) did not find any difference in clinical outcomes between the lateral condensation and CBO technique performed with Thermafil obturator.

Hence we may conclude that the two tested CBO showed similar positive results. Both filling systems were quick and easy to perform even when severe curvatures were present. The present study emphasized the need to precisely verify the matching between preparation and obturators with verifiers.

References