Abstract

Aim: comparison of four methods of gutta-percha root canal filling performed by warm vertical condensation, with the conventional method of cold lateral condensation of the gutta-percha. Objectives: to compare the density of root canal fillings by X-rays pictures and volume control.

Materials and method: Fifty inferior incisor and premolar root canals have been rotary-shaped with ProTaper files and then randomly divided into 5 groups, each of 10 teeth. The test groups were filled according to 4 distinct vertical warm gutta-percha condensation techniques, as follows: thermal compaction, hybrid technique, continuous wave, and multiple wave. The last 10 teeth of the control group were filled by cold lateral condensation. All root canal fillings were assessed by both X-rays pictures (2D) and tooth-clearing method (3D).

Results: The density of root canal fillings performed by thermal compaction, hybrid technique, and continuous wave was better than that obtained after using multiple wave. All vertical compaction techniques successfully filled most of the lateral canals situated in the middle third of the root.

Conclusions: The highest density of root canal fillings was registered by thermal compaction, the extruded material being not significantly related to the used technique.

Keywords: vertical condensation, lateral condensation, tooth-clearing method.

INTRODUCTION

The vertical warm gutta-percha condensation techniques substantially improved the clinical efficiency of the root canal treatment [1,2], a recent paper showing that some of them, such as thermal compaction and multiple wave, efficiently fill the lateral canals belonging to the middle third of the root [3]. However, the quality of root canal filling related to hindering of external microbial infiltration is not yet acceptable [4].

The present study evaluated 4 vertical gutta-percha condensation techniques (warm vertical multiple waves, warm vertical continuous wave, thermal compaction, and hybrid technique), involving filling of the apical third of the root canal by multiple wave condensation, and the rest of it by thermal compaction, comparatively with cold lateral condensation.

In that respect, we aimed to assess in vitro the risk of apical extrusion, as well as the quality of root canal filling of the afore-mentioned techniques, comparing the 2D X-rays pictures with the 3D microscopic images provided by the tooth-clearing procedure.

MATERIALS AND METHOD

A number of 50 inferior incisors and premolars that preserved their anatomical integrity were randomly shared into 5 groups, each of 10 teeth, having in all 54 root canals.

Shaping and cleaning

Working length was measured for every tooth under direct visual control, with a steel K file ISO 08 (FKG Dentaire), watching the moment when its tip appeared at the apical foramen. The first K file slightly banded at apical constriction indicated the diameter of the root canal at that level.

We manually performed the gliding path with steel K files ISO 08-10-15 (FKG Dentaire) and rotary instruments for root canal shaping by Ni-Ti files ProTaper Universal (Dentsply-Maillefer). Canal plus (Septodont) gel and simultaneous
2.5% NaOCl irrigation of 10 ml for each root canal delivered by Endo-Eze (Ultradent) needles and syringe have also been used. The final apical diameter of the main root canal was between ISO 20-40.

**Root canal filling**

The root canal has been dried by paper points and slightly coated with sealer, Tubliseal Xpress (Sybron Kerr), using a K file, through pumping and counter-clockwise movements. The selected gutta-percha point was dimensionally similar to the last ProTaper rotary file used in the apical part of the root canal.

*First experimental group* (10 teeth with 10 root canals): the apical third of the canal has been filled by continuous wave technique using the System B Pack (Sybron) while, in the more coronal part, hot gutta-percha has been injected by System B Fill (Sybron).

*Second experimental group* (10 teeth with 12 root canals): the apical third of the canal has been filled by the multiple wave technique; in the middle and coronal part, hot gutta-percha has been injected by System B Fill (Sybron).

*Third experimental group* (10 teeth with 11 root canals): the whole root canal filling was performed by thermal compaction using gutta-condensers (Dentsply-Maillefer).

*Fourth experimental group* (10 teeth with 11 root canals): the apical third of the canal has been filled by the multiple wave technique, and the more coronal part by thermal compaction of a gutta-percha point ProTaper F2 Universal (Dentsply-Maillefer).

*Fifth experimental group* (10 teeth with 10 root canals): the root canals have been filled by cold lateral condensation.

Radiographs have been performed for every tooth in two incidences, bucco-lingual and mesio-distal, and the access cavities have been sealed by composite resin Filtek Z250 (3M ESPE AG). Tooth-cleaning has been performed according to Venturi’s protocol [5], morphological analysis – by a stereo-microscope Zeiss Stemi 2000-C (Carl Zeiss Jena) and the photographs were taken with a photo-camera Nikon D60. Our data were statistically analyzed by the PASW Statistics 18 (SPSS) statistic software.

**RESULTS**

The extrusions have been evaluated according to 4 categories: A category – no extrusion, B category – sealer extrusion, C category – gutta-percha extrusion, D category – both sealer and gutta-percha extrusion. All filling methods, especially thermal compaction, showed extrusions (Table I). No extrusions were found in most of the root canals, except for 5 of them, where a combined extrusion of sealer and gutta-percha was noticed.

No statistically significant association between the filling technique and the category of extrusion has been found ($p>0.05$).

<table>
<thead>
<tr>
<th>Filling technique</th>
<th>Category</th>
<th>Total number of root canals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Thermal compaction</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Hybrid technique</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Continuous wave</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Multiple wave</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Cold lateral condensation</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>23</strong></td>
<td><strong>26</strong></td>
</tr>
</tbody>
</table>

**Radiographic quality of the root canal fillings** has been assessed on a 4 point scale basis [6]. In terms of radiographic density, the thermal compaction (score 1) prevailed, followed, in descending order, by the hybrid technique, continuous wave, cold lateral condensation, and multiple wave (Table II). All techniques have shown better results in bucco-lingual than in mesio-distal X-rays incidence.

**Microscopic assessment of the lateral and accessory canals fillings** has been done on a 6 score scale basis, according to a previous study [5], as follows: score 0 – unfilled, score 1 – partially filled with sealer but no gutta-percha, score 2 – partially filled with sealer and gutta-percha, score 3 – fully filled with sealer but no gutta-percha, score 4 – fully filled with sealer.
and partially with gutta-percha, score 5 – fully filled with both sealer and gutta-percha.

**Table II** – X-rays assessment of root canal fillings on 4 points scale basis

<table>
<thead>
<tr>
<th>X-rays assessment</th>
<th>Thermal compaction</th>
<th>Hybrid technique</th>
<th>Continuous wave</th>
<th>Multiple wave</th>
<th>Cold lateral condensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 well condensed and adapted</td>
<td>95.3%</td>
<td>50%</td>
<td>45%</td>
<td>8.2%</td>
<td>25%</td>
</tr>
<tr>
<td>2 faulty condensed, voids &lt; 1mm</td>
<td>4.7%</td>
<td>45.4%</td>
<td>25%</td>
<td>42.6%</td>
<td>35%</td>
</tr>
<tr>
<td>3 irregularities between 1-2 mm</td>
<td>0</td>
<td>4.6%</td>
<td>25%</td>
<td>32.8%</td>
<td>20%</td>
</tr>
<tr>
<td>4 irregularities &gt; 2 mm</td>
<td>0</td>
<td>0</td>
<td>5%</td>
<td>16.4%</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Table III** – Microscopic assessment of the lateral and accessory canals filling

<table>
<thead>
<tr>
<th>Score</th>
<th>Number of canals</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

| Total number of canals | 55 |

Only 39 out of the 55 identified lateral and accessory canals have been partially or fully filled (Table III). The most effective technique for filling the lateral canals has been thermal compaction (11 canals), followed by multiple wave vertical condensation (8 lateral canals), continuous wave vertical condensation (7 canals), cold lateral condensation (7 canals), and hybrid technique (6 canals). Most of the filled lateral canals (18) have been situated in the middle third of the root. The others have been distributed in the apical (12 lateral canals) and coronal (9 lateral canals) third of the tooth root.

**DISCUSSION**

In our study, extrusions were found in over 50% of the root canals (31 out of 54). Thermal compaction was always followed by either sealer extrusion or combined sealer with gutta-percha. Even if the hybrid techniques showed the same sort of extrusions, some other root canals were rightly filled (Fig. 1). Warm vertical continuous wave or multiple wave methods and cold lateral condensation produced less extrusion, mainly of the sealer (Fig. 1). Actually, lateral condensation
registered about the same number of extrusions as multiple wave vertical condensation.

The high scores of the lateral canals situated in the middle third of the root that had been filled especially by thermal compaction suggest the occurrence of pretty strong vertical condensation pressures into the main root canal. Even so, it has to be highlighted that we did not find statistically significant associations with a specific condensation technique [3,7].

Radiographic assessment exposed in the bucco-lingual incidence pointed out a higher density of the root canal filling, compared to the mesio-distal incidence, an aspect already described in previous papers [3,5,8]. The best homogeneity was noticed when thermal compaction was used, because gutta-percha was efficiently plasticized and mixed with the sealer by gutta-condenser. As to filling density, the hybrid and continuous wave technique were under the performance of thermal compaction (Fig. 2).

A higher ratio of non homogeneous root canal filling was present in the multiple wave technique, whereas cold lateral condensation registered intermediary fluctuant values. A possible reason might be spreader’s penetration within the final 1 mm of the root canal along the 0.02 ISO gutta-percha point, improving the homogeneity of the root canal filling [2,4,9].

Even if, commonly, it is generally accepted that a better density of the root canal filling occurs in warm vertical condensation, compared to the cold lateral one, our results report the insufficient plasticity acquired by gutta-percha within the apical 3-5 mm during the procedure of multiple wave vertical condensation. In this respect, the multiple wave technique might become a simple alternative to cold lateral condensation [4].

Another hypothesis concerning the similar ratio of faulty condensed root canal fillings with voids less than 1 mm, occurring when using hybrid technique and multiple wave vertical condensation, might be the comparable sealer thickness and the degree of gutta-percha compaction within the apical third of the root canal, as well [2].

It seems that the root canal filling techniques do not significantly influence sealer penetration into the dentinal tubules, but have under control its thickness. Consequently, in order to preserve for a long time the clinical efficiency of an endodontic treatment, it might be reasonably to attempt at reducing both sealer thickness and voids, as well [2].

CONCLUSIONS

There is no significant correlation between the extrusion of the root canal filling material and the method of filling, whichever it might be: thermal compaction, hybrid technique, warm vertical continuous wave, warm multiple wave condensation or cold lateral condensation.

An effective penetration of gutta-percha in the lateral canals of the middle third of the root occurs, without significant differences, after root canal filling by thermal compaction, hybrid technique and both warm vertical condensation, continuous and multiple wave.

The most homogeneous root canal fillings occur after thermal compaction, followed by hybrid technique and vertical continuous wave condensation. The least homogeneous ones are the result of cold lateral condensation and vertical multiple wave condensation.

Cold lateral condensation, with acceptable homogeneity and reduced risk of extrusion, is a method of root canal filling still recommended for routine use.

References

3. Scărlătescu S.A., Iliescu A., Didilescu A.C., Ștefan D.S., Iliescu Al.A. Evaluarea a patru metode de obturație de canal cu gutaperca prin tehnica transparentizării. in print


