AN IN VITRO ASSESSMENT OF CORONAL MICROLEAKAGE IN ROOT-FILLED TEETH

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Abstract

Aim. To evaluate the marginal seal of temporary restorations in endodontically-treated teeth by comparing three restorative materials and two techniques of root canal filling.

Materials and method. Canal shaping was completed on 72 single-root teeth using a ProTaper system and root filling by lateral or vertical condensation. 8 teeth have been positively or negatively controlled. Citodur, glass ionomer or zinc oxide eugenol were inserted into the access cavity. All teeth were immersed for 9 days in India ink, then cleared and evaluated for dye penetration.

Results. All groups of temporary restorations showed no significantly different marginal dye penetration. The glass ionomer cement presented the highest penetration.

Conclusions. The restorative materials used could not stop dye penetration in the access cavity. They are not reliable for avoiding microleakage in root-filled teeth in case of long-term fillings.

Keywords: coronal seal, tooth-clearing, marginal microleakage.

INTRODUCTION

The longevity of a successful endodontic treatment depends mostly on the coronal seal. Most of the root-filled teeth are lost because of coronal leakage, which allows infiltration of saliva and of numerous bacterial metabolic end products, virulence factors, antigens.

As root canal filling cannot avoid marginal percolation, it is a paramount need to maintain a good seal of the coronal restoration for preventing, as long as possible, the main pathogenic consequence: chronic apical periodontitis.

In a 3-year follow-up study, Cagidiaco et al. reported that success of endodontic treatment on premolars covered by ceramic full crown, the survival rate of root-filled teeth reaching 76.7%. They also noted a direct relation between the clinical success and the volume of remaining hard tissues of the teeth [1].

The aim of the present investigation was to evaluate the marginal leakage of coronal restorations that might occur in root-filled teeth when using common temporary restorative materials, such as Citodur, zinc oxide eugenol and glass ionomer cements.

Also, a comparison was made between the occurrence of microleakage in the cervical area of the root-filled teeth when applying two different root filling techniques, namely lateral versus vertical condensation, and also two different sealers: the AH Plus epoxy cement versus the Tubliseal zinc oxide eugenol-based cement.

MATERIALS AND METHOD

Root canal shaping by the ProTaper system and root canal filling by lateral or vertical condensation using two sealers, AH Plus and Tubliseal, were performed in 80 single-root teeth, lower incisors and premolars, having together 83 main root canals. The teeth were randomly divided into three groups of 24 teeth each, depending on the temporary restorative materials used: Citodur, zinc oxide eugenol, and glass ionomer cement. The positive control group included 4 teeth without coronal restorations the root canals of which were only shaped but not filled.
The negative control group also included 4 teeth with coronal restorations whose root canals were shaped and filled according to the method used by Davalou et al. [2].

Once the glide path was manually obtained with K files (FKG Dentaire) size ISO 08, ISO 10, and ISO 15, cleaning and shaping of the root canals were performed by Ni-Ti rotary files Protaper Universal (Dentsply-Maillefer) using simultaneously Canal plus jelly (Septodont). After each file, the root canal was irrigated with 2 ml of 2.5% sodium hypochlorite delivered by Endo-Eze needles (Ultradent). The teeth were additionally flushed for 2 min to remove the smear layer with 2 ml of a 17% EDTA solution, followed by a 5 ml final irrigation with 2.5% sodium hypochlorite.

The root canals were dried with paper points and their walls were separately coated – in equal ratios – with AH Plus Jet (Dentsply-DeTrey) and Tubliseal Xpress (Sybron Kerr) sealers. In each group of study, 50% of the teeth were filled by lateral condensation to the cervical border of the root canal, according to the method described by Koagel et al. [3].

In the remaining 50% teeth, the B Pack System was applied, according to the vertical condensation technique of continuous wave. The selected gutta-percha point corresponded to the last Ni-Ti ProTaper apical file and the canal was completely back-filled injected with warmed gutta-percha, by System B Fill.

In the first group of teeth, temporary coronal restoration made use of freshly mixed zinc oxide eugenol, in the second group the inserted restorative material – of Citodur hard (Dorident-Austria) and in the last group – of a glass ionomer cement Ketac Molar Easymix (3M ESPE).

All teeth were covered with two layers of nail varnish (Farmec SA, Cluj-Napoca, Romania) on the whole root surface, up to 1 mm from the border of coronal restoration, according to the method used by Davalou et al. [2]. In the negative control group, the whole tooth surface has been covered by two layers of nail varnish while, in the positive control group, the tooth surface has been completely left uncovered.

Further on, the teeth were immersed in vertical position in India ink (Windsor & Newton, London, UK) and, after a 9 day-exposure to the dye, the varnish was carefully removed with a scalpel. Tooth clearing followed the protocol of Venturi [4]. Dye penetration was recorded by photocamera Nikon D 5100, under stereomicroscope Zeiss Stemi 2000-C (Carl Zeiss Jena) examination.

Statistical analysis was performed using the Stata IC 11 (StataCorp 2009, TX, USA) software. The data were collected by measuring coronal leakage [2] according to the distance between the cervical position of the root canal filling and the deepest dye penetration along the temporary restoration towards the root apex (Fig. 1).

On the average, the width of the restorative material was around 5 mm. In cases of root-filled teeth associated with deep caries or very large access cavities, the width of the temporary restorative material was less than 3.5 mm and dye penetration extended into the cervical third of the root.

RESULTS

In root-filled teeth with temporary restorations, the average values of dye penetration on the buccal and lingual areas of the root canals in their cervical third are separately exposed for each restorative material (Tables I and II).
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Table I. Dye penetration into the buccal area in the cervical third of the root canal

<table>
<thead>
<tr>
<th>Restorative materials</th>
<th>Filled-root canals</th>
<th>Average (mm)</th>
<th>Standard deviation</th>
<th>Minimal dye penetration (mm)</th>
<th>Maximal dye penetration (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc oxide eugenol</td>
<td>26</td>
<td>1.266</td>
<td>1.635</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Citodur</td>
<td>31</td>
<td>1.136</td>
<td>1.209</td>
<td>0</td>
<td>4.34</td>
</tr>
<tr>
<td>Ketac Molar</td>
<td>26</td>
<td>1.499</td>
<td>1.320</td>
<td>0</td>
<td>3.95</td>
</tr>
</tbody>
</table>

Table II. Dye penetration into the lingual area in the cervical third of the root canal

<table>
<thead>
<tr>
<th>Restorative materials</th>
<th>Filled-root canals</th>
<th>Average (mm)</th>
<th>Standard deviation</th>
<th>Minimal dye penetration (mm)</th>
<th>Maximal dye penetration (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc oxide eugenol</td>
<td>26</td>
<td>1.393</td>
<td>1.516</td>
<td>0</td>
<td>4.85</td>
</tr>
<tr>
<td>Citodur</td>
<td>31</td>
<td>1.147</td>
<td>1.074</td>
<td>0</td>
<td>2.97</td>
</tr>
<tr>
<td>Ketac Molar</td>
<td>26</td>
<td>1.743</td>
<td>1.481</td>
<td>0</td>
<td>3.76</td>
</tr>
</tbody>
</table>

The average area of dye penetrations into the cervical third of the filled root canal was higher in the case of Tubliseal, comparatively with AH Plus, even if no statistically significant difference was recorded between these sealers (p>0.05) – as it was also the case of the filling techniques of the root canals.

No statistically significant differences were recorded among the restorative materials, however the glass ionomer cements produced the deepest penetrations.

18 root canals out of 83 (21.68%) showed no dye penetration into the cervical third of the root canal. The temporary restorative materials used have been: zinc oxide eugenol – in 7 teeth, Citodur – in 7 teeth and glass ionomer cement – in 4 teeth.

All teeth belonging to the negative control group showed no dye penetration, while all teeth from the positive control group showed evident dye penetration along the whole length of the root canal. The root filling technique of lateral condensation (Fig. 2) as well as the backfill procedure (Fig. 3) produced voids highlighted by dye penetration along the the root canal wall. As to the temporary restorative materials, zinc oxide eugenol (Fig. 4) was found as sealing more efficiently than both Citodur (Fig. 5) and the glass ionomer cement (Fig. 3).

DISCUSSION

The tooth clearing technique is an useful tool for getting information on the internal design of the endodontic system and on the assessment of root canal fillings. Even if dye penetration tests have been intensively used for many years to evaluate the real value of the root canal fillings,
their passive way of working allowed only a qualitative appreciation. In this respect, Rechenberg et al. emphasized that the tooth clearing technique is not a true pointer of clinical success or failure for root canal treatments [5].

Although all temporary restorative materials proved leakage (78.31%), dye penetration was seen as being located in the cervical third of the root canal in only 65 teeth. Anbu et al. consider that microleakage represents the effect of either coronal restorations without a good marginal seal or of certain uninstrumented and unfilled internal morphologic complexities of the endodontic system [6].

The present study shows that, during lateral condensation and the backfill procedure linked to vertical condensation, some voids might be generated along the root canal walls, facilitating further dye penetration.

Accordingly, deeper penetrations should be mentioned while using Tubliseal. Our results agree with those of Mokeem-Saleh et al. [7] and Mutal and Gani [8], who demonstrated that zinc oxide eugenol-based sealers have larger pores and vacuoles than the epoxy resins and glass ionomer sealers.

Even if the B Fill System provides an excellent moulding of gutta-percha in the middle and cervical third of the root canals, as already demonstrated by Scârlătescu et al. [9], the present study evidenced some permeable root canal fillings in lower incisors and premolars. Comparatively with other temporary restorative materials, the glass ionomer cement proved the highest number of dye penetrations, followed, in decreasing order, by Citodur and zinc oxide eugenol. Our results, similar to those of Zaia et al. [10], might be explained by shrinkage of the restorative material (Pieper et al.) [11].

Citodur is a hygroscopic material that expands during setting. Its better marginal seal, as compared to that of the glass ionomer cement, could be explained by a larger setting linear expansion (Pieper et al.) [11]. As to zinc oxide eugenol, this is a reliable temporary restorative material which provides protection against marginal leakage and has a good antibacterial activity. Its insertion has to be done under pressure, to get a convenient adaptation to the walls of the access cavity (Pitt Ford et al.) [12].

In some study specimens with previous proximal caries, especially in premolars, the access
cavities filled with temporary restorative materials did not preserve the anatomic integrity of all their walls because the marginal ridge of the tooth crown was destroyed.

Another causal effect of dye penetration beyond the cement enamel junction might be the poor adaptation of the temporary restorative material at the emergence orifice of the root canal, where it directly contacts the gutta-percha and the sealer.

According to Wells et al., for a better protection against leakage, it is crucial to remove 2-3 mm from the coronal end of the root canal filling and to replace it with adhesive and dimensionally-stable restorative materials [13].

CONCLUSIONS

In our in vitro study, none of the materials tested for temporary restorations could avoid marginal dye penetration. The most evident microleakage occurred in the case of the glass ionomer cement, which showed a higher degree of in-depth penetration, compared to zinc oxide eugenol and Citodur. A relatively higher leakage in the coronal third of the root canals, where Tubliseal sealer had been used, could be also observed.

References