Influence of the timing of post space preparation on apical sealing

Influência do timing da colocação de retentor intra-radicular no selamento apical

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ABSTRACT

Objective
To evaluate the integrity of the apical seal in root filled teeth following immediate post space preparation and after eight days.

Methods
Forty extracted single-rooted human teeth were instrumented and filled, using lateral condensation technique, with gutta-percha and Sealapex® sealer (Kerr-Sybron, Scafati, Italy). The teeth were randomly assigned to four groups: group I (GI) with seventeen teeth (immediate post space preparation), seventeen in group II (GII) (delayed post space preparation) and three teeth in each control group, group III (GIII) positive control and group IV (GIV) negative control. In GI and GII, the post space was prepared with ProTaper Universal® retreatment files (Dentsply/ Maillefer, Ballaigues, Switzerland). After the post space preparation, all specimens were coated, except for two apical millimeters, immersed in methylene-blue dye for eight days, and then sectioned longitudinally. The extent of staining was examined under a stereomicroscope.

Results
In GI there was an average apical leakage of 7,42 mm, while in GII it was 6,82 mm. There were no statistically significant differences between groups I and II (p>0.05).

Conclusion
The timing of post space preparation, in teeth filled with Sealapex® sealer (Kerr-Sybron, Scafati, Italy), did not affect the apical sealing ability.

***Indexing terms**: Dental cements. Endodontics. Root canal preparation.*

RESUMO

Objetivo
Avaliar o selamento apical em dentes desobturados imediatamente após a obturação radicular e desobturados oito dias depois, para a colocação de retentor intra-radicular.

Métodos
Quarenta dentes unirradiculares, foram instrumentados manualmente e obturados pela técnica de condensação lateral com cones de guta-percha e cimento Sealapex® (Kerr-Sybron, Scafati, Italy). Foram aleatoriamente distribuídos em 4 grupos. Grupo I (GI) 17 dentes - desobturação imediata; Grupo II (GII) 17 dentes - desobturação tardia; Grupo III (GIII) 3 dentes - controle positivo; Grupo IV (GIV) 3 dentes - controle negativo. Para a desobturação (GI e GII) foram utilizados instrumentos mecanizados de retratamento ProTaper Universal® (Dentsply/Maillefer, Ballaigues, Switzerland). Após desobturação, os dentes foram impermeabilizados com esmalte, exceto nos 2 milímetros apicais, foram imersos em solução de azul-de-metileno durante 8 dias e seccionados longitudinalmente. Com o auxílio de uma lupa "Wild Makroskop M420" foi realizada a leitura da infiltração.

Resultados
No GI, obteve-se infiltração apical média de 7,42 mm e no GII de 6,82 mm. Estas diferenças não foram estatisticamente significativas (***p***>0,05).

Conclusão
O momento de desobturação para a colocação de retentores intra-radiculares, de dentes obturados com cimento Sealapex® (Kerr-Sybron, Scafati, Italy), não afetou o selamento apical.

Termos de indexação: Cimentos dentários. Endodontia. Preparo de canal radicular.

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INTRODUCTION

Endodontic sealers are important for obtaining excellent sealing, aiming to eliminate as much as possible the interface between the gutta-percha and the dentin walls of the filled root canals. Therefore, they are evaluated according to their ability to promote apical sealing, which is fundamental to the success of endodontic treatment[1]. The main objectives of the chemomechanical preparation are the cleaning and shaping of the root canal system, whose purpose is three-dimensional filling. The root canal filling should perpetuate the state of reduction and potential elimination of the micro-organisms and/or irritants, preventing endodontic reinfection. After the endodontic treatment, the remaining dental structure may require a post to retain the restoration and replace the lost tooth[2]. To prepare the post space it is necessary to remove a portion of the filling material that may cause displacement of the root canal fillings, which can affect the sealing ability. The remaining filling material may be displaced, creating gaps in the filling due to the vibration produced by the instruments used to remove it[3]. Other factors, such as the obturation techniques[4-5], the method used to remove the filling material[5-7], the amount of remaining apical filling[8-9] and the timing of post space preparation[5-6,9-13] may affect apical sealing. The time interval between post space preparation and the crown restoration is critical in preventing recontamination of the filling material[12,14]. However, there is no consensus as to the ideal moment to perform post space preparation; some authors propose immediate post preparation[9,11-13,15] whereas others reported no significant differences between the immediate or delayed removal of the root canal filling[7,16].

According to Grossman[17], the sealing capacity of root canal sealers could be related to their physical characteristics, such as flow, setting time or polymerization contraction. Because gutta-percha is impermeable, leakage will occur at the gutta-percha/sealer interface or the sealer/dentin wall interface[4].

Resin-based sealers are currently preferred due to their physical properties[16,18]. Calcium-hydroxide-based sealers may be used to improve the sealing of the apical region, increasing the success of the endodontic treatment[1,19]. The inclusion of calcium hydroxide in salicylic resin sealers (Sealapex®, Kerr-Sybron, Scafati, Italy) could, in this way, improve the prognosis of endodontic treatment [20].

The aim of this study was to evaluate the integrity of the apical seal when post space was prepared immediately and after eight days using Sealapex®, a calcium hydroxide based sealer (Kerr-Sybron, Scafati, Italy).

METHODS

Forty natural single-rooted human teeth were used in this ex vivo study. The selected teeth, extracted for a variety of reasons, had intact roots, straight or had a slight curvature, a single canal and completely formed apices. Central and lateral incisors, canines and premolars were used, there being no distinction between them for the purposes of the study. After extraction, teeth were stored in a physiological solution in a closed glass container. Prior to carrying out the endodontic access, all the teeth were x-rayed in the vestibular-lingual/palatal direction, with the existing periodontal tissue and/or tartar having been removed, resorting to dental picks and ultrasound. Endodontic access was performed in accordance with the universally accepted general principles of coronal opening, so as to obtain the best possible access to the root canal. The working length was calculated at 1 mm from the radiological apex and all the teeth were subsequently instrumented manually using the standard technique and irrigated between each file, in a sodium hypochlorite solution at 3% (NaOCl 3%). When the preparation was complete, the root canal was finally irrigated with a solution of EDTA (Q-solution EDTA, Denta Flux, Algete (Madrid), Spain) at 17% for 1 minute, ending with one last rinse with a solution of NaOCl 3%. As the objective was to study the apical sealing through filling materials, a patency file was always used to verify the permeability of the apical portion of the canal, as these could have an impact on the results. The teeth were distributed randomly into 4 groups. Group I (GI): 17 teeth for immediately post space preparation; group II (GII): 17 teeth for delayed post space preparation; group III (GIII) and group IV (GIV) with 3 teeth each, for control groups. The teeth were stored in physiological solution at room temperature. The specimens of GI and GII were filled along the entire length with gutta-percha (Dentsply, Ballaigues, Switzerland) and a calcium-hydroxide-based sealer (Sealapex®, Kerr-Sybron, Scafati, Italy), using the lateral condensation technique. The post space was prepared immediately (GI) and eight days after obturation (GII). The root canal fillings were removed leaving 5 mm of remaining apical fill. The post

space preparation was carried out with ProTaper Universal® mechanical retreatment instruments (Dentsply/Maillefer, Ballaigues, Switzerland), according to the manufacturer's recommendations, with a "Tecnika" motor (Dentsply/Maillefer) and with Hedstroem files (Dentsply/Maillefer, Ballaigues, Switzerland) to remove the remaining filling material from the canal walls. In groups GI and GII, the roots were covered with two layers of transparent "L'Oreal Paris" nail varnish (France), except for the apical 2 mm. Groups GIII and GIV, each having 3 teeth, comprised the positive and negative control groups, respectively. These teeth were also instrumented but not obturated. In order to carry out the positive control, the GIII teeth were not covered with varnish while the negative control specimens (GIV) were completely covered using two layers of varnish, including the region of the foramen. The coronal portion was sealed with sticky wax. The specimens were immersed in a glass recipient containing a solution of methylene blue at 2%, ensuring that only the apical portion remained in the solution. The container was stored at a temperature of 37ºC for a period of eight days, with the amount of dye in the container constant. Once the time of the experiment was up, the teeth were removed from the solution and wrapped in gauze. For leakage evaluation, all the specimens were sectioned longitudinally using a spatula and making a small rotation along the cuts made to the teeth using a tungsten diamond disc, one on the vestibular surface and the other on the lingual/palatal surface. These cuts were made such that they did not come into contact with the root canal and the filling material would not suffer any form of alteration. One half of each tooth was then selected at random for observation with the aid of a "Wild Makroskop M420" magnifying glass owned by the Dental Anatomy Laboratory in the Faculty of Dental Medicine at the University of Oporto (FMDUP). Digital photographs were taken at 7x magnification and the leakage was then measured using the "Leica Qwin Lite V2.3, 1998" program calibrated at 2.5x, taking into consideration the most coronal point of leaked dye. The measurements were examined and recorded by 3 observers and the values were transferred to an Excel 2007 worksheet.

In accordance with the Declaration of Helsinki (2000), the present study is exempted from evaluation by the Ethics Committee of the University of Oporto, filed under protocol no. 8 1296.

The statistical analysis was performed using the software application IBM SPSS 19.0 (SPSS Inc., Chicago, Illinois, USA), with the assistance of the independent t-test, which compared apical leakage between immediate and delayed post space preparation, establishing a level of significance of $p<0.05$.

RESULTS

Group GI shows average leakage of 7,42 mm and GII 6,82 mm, with the respective standard deviations of 1,12 and 1,1. The analysis shows that GII exhibited the least leakage of dye, however these differences are not statistically significant ($p>0.05$). In the positive control group (GIII), the dye infiltrated the entire length of the tooth while in the negative control group (GIV), no form of leakage was observed. Due to procedural error in the laboratory, 6 samples were excluded from GI and 6 from GII.

DISCUSSION

In the present study, the apical leakage was measured of single-root teeth previously filled with gutta-percha and a calcium-hydroxide-based sealer (Sealapex®, Kerr-Sybron, Scafati, Italy) via a solution of methylene blue, a method frequently employed to evaluate leakage[4,13,15-16]. Other methods of assessing leakage are also suggested: electrochemical[5], fluid transport[11], radioactive isotope[9], the diffusion of radioactive markers under pressure[10], bacterial leakage method[6,14,18] and the use of a vacuum prior to the diffusion of the dye[4,15]. The method adopted is considered to be one of the most sensitive and easy to reproduce[21-22], and continues to be the standard in these study models[23-24]. In order to perform an ex vivo evaluation of the apical sealing in teeth where post space preparation was carried out either immediately or eight days after, the same protocol was used as in an earlier study[12], except that the sealer used had different chemical properties. It was suspected that the setting time of the different sealers (zinc-oxide-eugenol based/calcium-hydroxide-based) might explain the conflicting results concerning the time interval of post preparation[25]. Many previous studies[4-5,12] preserved 5 mm of obturation material, although other authors[8,10] have questioned whether this remaining amount of filling material is ideal for preserving the apical seal. Protaper Universal® (Dentsply/Maillefer,

Ballaigues, Switzerland) mechanical instruments were used instead of Gates-Glidden drills, frequently used as a mechanical method for removing gutta-percha from root canals[4-5,10,13,18], in an attempt to minimize the excessive removal of dentin that these drill bits cause[26]. The present study did not evidence a statistically significant difference in leakage between immediate post space preparation and after eight days. These results approximate those obtained by Grecca et al.[6] with AH Plus® sealer (Dentsply DeTrey, Konstanz, Germany), Abramovitz et al.[10] with AH26® sealer (Dentsply, Konstanz, Germany) and Aydemir et al.[5] with Sealapex® (Kerr-Sybron, Scafati, Italy) and Diaket® sealers (ESPE, Seefeld, Germany). Other authors also found no difference between immediate or delayed post space preparation[7,9,11].

Studies with zinc-oxide-eugenol based sealers[4,11,12,15], or with resin-based sealers[13] quote higher leakage values with delayed post space preparation. Based on these results, it is recommended that the restoration of teeth filled with these sealers and which require a post, should be performed immediately after the obturation. As well as the professional being more familiar with the anatomy of the canal and the points of reference for the removal of the filling, the risk of sealer disintegration and consequent influence on the integrity of the apical seal will be diminished. Furthermore, delayed post space preparation, particularly when carried out without taking care to achieve absolute isolation, could increase the risk of contamination and affect the success rate of the completed root canal treatment[6,13,16].

The results of the present experiment contradict the results of our earlier study[12] where there was a statistically significant difference between the timing of post space preparation. In this study[12] and in agreement with other studies[4,11,15], the delayed post space preparation was associated with more leakage than immediate preparation when a zinc-oxide-eugenol based sealer was used. This sealer has a fast setting time and reduced tensile strength[27], which might explain these results. When a post space was prepared immediately after filling, the sealer had not yet set and consequently did not suffer the effects of vibration from the rotary instruments, whereas in delayed post space preparation, with the sealer already set, displacement and microcracks in the obturation material could have occurred and affected the quality of the apical sealing of the obturation, with consequently greater leakage. In addition, Solano et al.[13] also reported results of greater leakage with delayed post space preparation with AH Plus sealer (Dentsply DeTrey, Konstanz, Germany), attributing this fact to the sealer´s setting time being only 8 hours; for immediate post preparation it had still not set, unlike delayed post preparation (8 days later).

Aydemir et al.[5], obtained lower leakage values with the thermoplastic obturation technique compared with the classic lateral condensation technique but did not find any significant difference between immediate and delayed post space preparation. Nevertheless, this study of delayed post preparation occurred four weeks after the obturation and the expression "immediate" signified a period of 40 minutes. It is possible that no difference was found because after 40 minutes, the setting of the zinc-oxide and resin sealer (Diaket®, ESPE, Seefeld, Germany) would be practically complete and for this reason it behaved identically to that of the four-week delay. As for the Sealapex® sealer (Kerr-Sybron, Scafati, Italy), with its longer setting time, it was still within its setting time and its physical properties were relatively similar at the two moments of post space preparation[25]. This sealer has a setting time of around four weeks[25], depending on conditions of humidity, so the physical properties were similar to the respective timings of 40 minutes and four weeks. Corrêa-Pesce et al.[16] also found no difference between the time interval of post preparation, using zinc-oxide-eugenol sealer (Endofill®, Dentsply DeTrey, Konstanz, Germany) and resin sealer (AH-Plus®,Dentsply DeTrey, Konstanz, Germany) when the post space preparation was carried out after 24 hours and 72 hours, respectively. In this case, at 24 hours the zinc-oxide-eugenol sealer was already set as it was at 72 hours; the same applies to the resin cement.

The role of the root canal sealers is to fill spaces that may exist between the solid obturation material and the canal's dentin walls. Attention must be paid to solubility, leakage and adhesion of a sealer. It is desirable for the sealer not to set too quickly or too slowly; a slow setting time gives the operator more time to work however it also means that the time during which coronal leakage could occur is longer[7]. Calcium-hydroxide-based sealers possess low solubility and diffusion capacity and the setting reaction is complex. Even when the surface layer sets, the internal layer could remain fluid for a longer period of time, up to four weeks in a humid environment, and not set at all in a dry emvironment[7].

The post space preparation is a critical moment, it being important to maintain aseptic conditions and the integrity of apical sealing of the endodontically treated tooth. The method used to remove the gutta-percha (mechanical, physical or chemical), the interval of time (immediate or delayed) of the post space preparation and the amount of remnant filling material could create a path for leakage and reinfection of the root canal[8]. The different sealers seem to produce different results according to their physicochemical properties. The root canal sealers have a limited and variable capacity to penetrate the dentin tubules and this could be influenced by previous procedures such as the removal of the smear layer or intracanal dressings, or subsequent procedures like post space preparation. In the literature, with so many contradictory results concerning the integrity of the apical seal, the timing of post space preparation remains ambiguous. It is evident that there is a need to select a sealer which provides hermetic sealing, the setting time of the selected endodontic sealer being a factor that could play a decisive role in the integrity of apical sealing.

CONCLUSION

Under the conditions of this study, we can highlight the importance of the properties of the root canal sealer on the integrity of the apical sealing in teeth that required post space preparation. The timing of the post space preparation in teeth obtured with Sealapex® sealer (Kerr-Sybron, Scafati, Italy) does not influence the integrity of the apical sealing.

Collaborators

J BARROS was responsible for the direction, methodology, composition of the article and interpretation of data. J CRUZ was responsible for carrying out the methodology and participated in the composition of the article. MF CARVALHO and I PINA-VAZ were responsible for the direction, final review of the article and its composition.

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