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ORIGINAL RESEARCH

Assessment of apical sealing of three warm obturation techniques in the presence of fractured NiTi rotary instruments

Evaluación del sellado apical de tres técnicas de obturación en presencia de instrumentos rotatorios de NiTi fracturados

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ABSTRACT

The purpose of the present study was to compare the sealing ability of three warm obturation techniques (thermo-plasticized gutta-percha): Schilders warm vertical compaction, McSpadden's thermo-mechanical compaction and Thermafil (Dentsply-Maillefer) in teeth fractured at the apical region. 30 extracted, single-rooted teeth were prepared with Pro-Taper (Dentsply-Maillefer). At the apical third of each of these teeth, ProTaper F3 rotary instruments were deliberately fractured. Teeth were randomly divided into three groups (n = 10) to be later filled with the selected technique, so that with dye penetration technique and with the aid of discoloring teeth technique, teeth could be microscopically assessed so as to determine the amount of apical microfiltration elicited in every technique. In all groups, specimens presented some degree of apical microfiltration. Teeth filled with Thermafil presented 3,134 µm average microfiltration. This microfiltration was significantly higher than the one observed with McSpadden thermo-mechanical technique and Schilder's vertical compaction technique ($p < 0.05$). These two techniques presented 1,934 µm and 2,083 µm respectively. McSpadden and Schilder´s technique show no statistically significant microfiltration differences ($p > 0.05$).

RESUMEN

El propósito de este estudio fue comparar la capacidad de sellado de tres técnicas de obturación con gutapercha termoplastificada, técnica de obturación vertical de Schilder, compactación termomecánica y Thermafil (Dentsply-Maillefer), en dientes con instrumentos fracturados en la región apical. Un total de 30 dientes unirradiculares extraídos fueron instrumentados con ProTaper (Dentsply-Maillefer), en cada uno de los mismos se fracturaron intencionalmente instrumentos rotatorios ProTaper F3 en el tercio apical. Los dientes fueron divididos aleatoriamente en tres grupos (n = 10) para ser obturados con la técnica correspondiente, para que, con la técnica de filtración de colorante y con la ayuda de la aclaración de los dientes fueran observados bajo microscopio para determinar la cantidad de microfiltración apical que permitía cada técnica. En todos los grupos, los especímenes presentaron alguna cantidad de microfiltración apical. Los dientes que fueron obturados con Thermafil presentaron una microfiltración promedio de 3,134 µm, resultando en significativamente mayor microfiltración que los obturados con la técnica termomecánica de McSpadden y de compactación vertical de Schilder, ($p < 0.05$) que obtuvieron un promedio de microfiltración de 1,934 µm y 2,083 µm respectivamente. Mientras que no existe diferencia estadísticamente significativa de microfiltración entre la técnica de McSpadden y la de Schilder ($p > 0.05$).

Key words: Microfiltration, sealing, instrument fracture, obturation.
Palabras clave: Microfiltración, sellado, fractura de instrumentos, obturación.

INTRODUCTION

One of the main objectives of endodontic treatment is the complete sealing of root canals after having achieved their cleansing and shaping. Nevertheless, this objective can be compromised by the presence of a fractured instrument.[1] Fracture of endodontic instruments within the root canal is a frequent problem, representing a major obstacle when performing routine root canal therapy.[1-3] There is a great variety of instruments that can separate within root canals, nevertheless it is common

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knowledge that nickel-titanium (Ni-Ti) rotary instruments fracture more frequently than stainless steel manual instruments.[4]

It has been observed that NiTi instruments more frequently fracture at the apical region of the root canal,[5] this hinders removal with conventional methods.[6,7] The fractured instrument fragment, by itself, does not warrant periapical surgery or tooth extraction.[8] Presence of a pre-surgical periapical lesion has a stronger clinical influence on a negative result than fractured instruments.[5]

Even though some previous laboratory works suggest the fact that fractured fragments do not play an important role in bacterial penetration into root canals compacted with lateral compaction technique,[9,10] the effect of obturation techniques with warm (thermo-plasticized) gutta-percha has not been widely researched. Due to this fact, the objective of the present study was to research apical sealing characteristics of three different compaction techniques with warm (thermo-plasticized) gutta-percha: McSpadden thermo-mechanics, Schilder vertical compaction and Thermafil on NiTi ProTaper rotary instruments (Dentsply-Maillefer) fractured at the apical region. The research was carried out using colorant filtration method.

MATERIALS AND METHODS

30 extracted human teeth were used for the study. For disinfection purposes, teeth were immersed in 1% sodium hypochlorite solution; soft tissue was removed and teeth were stored in de-ionized water until the required number of teeth was completed.

Crowns were removed with a cut perpendicular to the longitudinal axis of the tooth, at the cement-enamel junction. To this effect a carbide disk with irrigation was used, so as to avoid any variable in the coronary approach.

Work length was determined with a number 10 file, used along the canal, until it protruded through the apical foramen. 1 mm was subtracted from the total length. A number 15 file was later introduced until reaching the working length so as to assess canal permeability.

Teeth were randomly divided into three experimental groups each comprising 10 teeth. Instruments were used in the canals with Pro-Taper system (Dentsply-Maillefer) at a 350 rpm speed. Irrigation was achieved with 2 mL of 2.5% sodium hypochlorite (NaCOl) and 2 mL of 17% ethylene-diamine-tetraacetic acid (EDTA) applied between use of each instrument. Preparation was carried out until reaching the point of a F3 file at 2 mm before reaching working length. Then a new F3 file was introduced. This file had previously received a fissure performed with a 2 mm diamond burr. This burr was placed over the tip to ease fracture. Even, constant pressure was applied until separation took place. After instrument separation, x rays were taken to verify the fact that separation had taken place at the canal´s apical third *(Figure 1)*. Before obturation, all specimens received Roth sealing cement (Roth International). This cement was introduced with a lentulus at 100 rpm speed. After this, canals were filled following the three techniques subject of the study.

Group 1 was filled with McSpadden thermo-mechanical (warm) compaction technique. For this technique, a M gutta-percha point (cone) was gauged

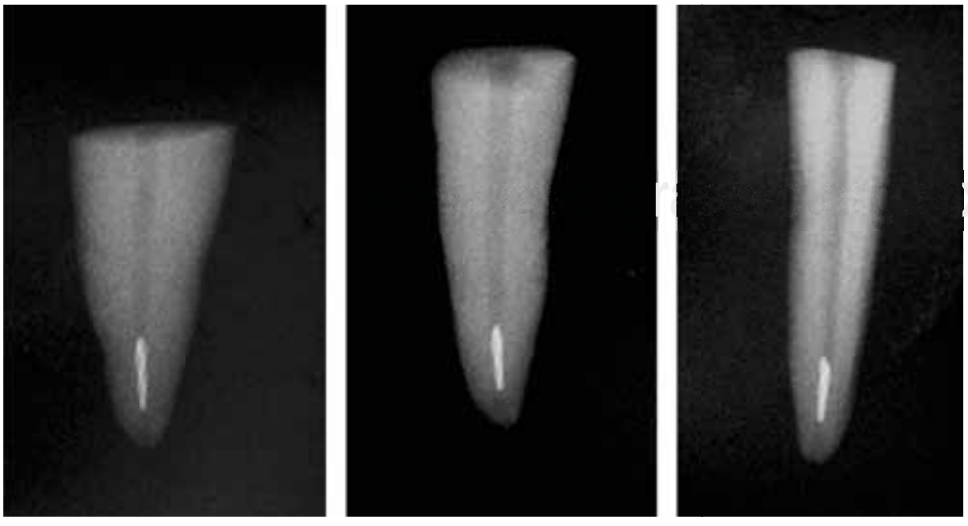

Figura 1. X-ray of apically fractured instrument.

until reaching the point of being adjusted. One or two accessory FM gutta-percha cones were placed within the canal, according to its anatomy. After this, a thermo-mechanical obturator was introduced (Moyco, M.R.) at 8,000 rpm speed, exercising high torque. The device was activated with an electrical engine with speed and torque control (VarioSurg NSK, Japan ®) until the canal was totally compacted. At the cervical end, a cotton swab and Provisit were placed as temporary obturation. Group 2 was filled with Schilder technique. A M guttapercha cone (Hygienic) was gauged to the canal size with the help of a gutta-percha cone gauging ruler (caliper ruler) (Maillefer ®). This ruler was heated within the canal with the Touch n'heat system (Sybron Endo, Sybron Dental Specialties ®), and was compacted into the apical third with the help of Schilders compactors (Maillefer ®). Another M gutta-percha cone was sectioned into 4 mm sections. These sections were then introduced into the canal in the same fashion, with the help of Touch n´Heat and greater size (caliber) Schilder compacters. This process was continued until completing obturation of the middle and cervical thirds. At the cervical end, a cotton swab and Provisit were placed as temporary obturation. Group 3 was filled following the Thermafil technique. A canal gauge of this system was used to ascertain canal diameter. Once the proper size was selected, the obturator was placed within the canal with even pressure. Once it was properly seated, the excess rod protruding from the canal was eliminated with a round burr. Light vertical compaction was undertaken and cotton swab and Provisit were put into place. After obturation, all teeth were radiographed (x-rayed) *(Figure 2)*.

Once filled, all specimens were painted with two layers of nail polish, except for the two last apical mm. Specimens were then covered with wax in the same fashion, up to 2 mm before the apex. Teeth were then immersed in 2% methylene blue, for 48 hours, at 37 °C and normal atmospheric pressure. At a later point, teeth were thoroughly cleansed under running tap water, to eliminate the dye with the help of a toothbrush. Wax and polish were removed from teeth where they had been applied, this process was carried on until teeth were thoroughly clean.

To measure micro-leakage, teeth were subjected to a decalcifying process conducted with 5% nitric acid, in aqueous solution, for 48 hours. This solution was replaced every 24 hours. After this period, teeth were rinsed in tap water during four hours and were dehydrated with ethyl alcohol at increasing concentrations of 80, 90 and 100% during twelve, two and three hours respectively. To complete the procedure, methyl salicylate was used to achieve conservation and diaphanization.

Once teeth were treated in the aforementioned manner, they were studied with the microscope. A measurement, calculated in microns, was conducted to assess amount of penetration encountered in each specimen.

Data were analyzed using one factor ANOVA as well as with a non parametric variance analysis, the Kruskal-Wallis test.

RESULTS

Microfiltration magnitude was measured through thorough observation with a 1.14E measure

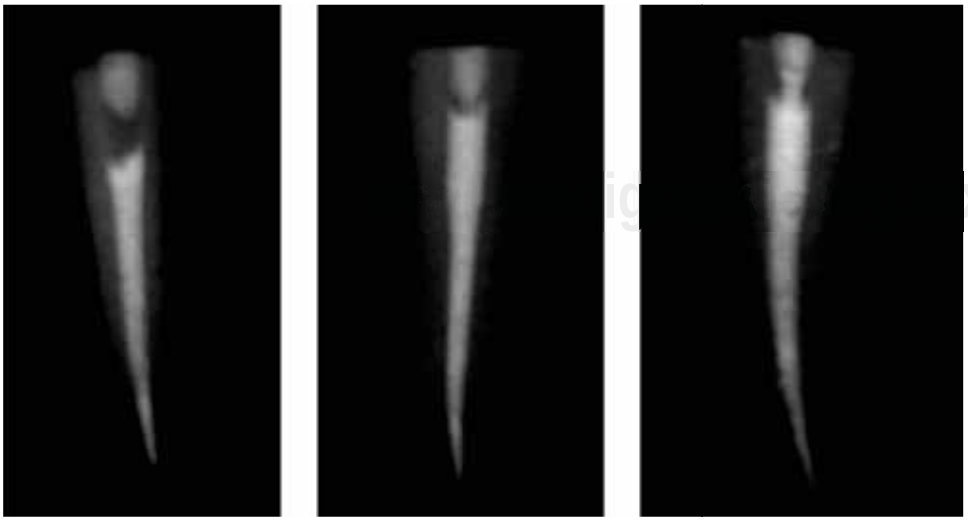

Figura 2. Obturation x-ray.

microscope, in which, every measurement line is equivalent to 48 µm, therefore, an equivalent conversion was required so as to be able to assess results in µm *(Table I)*.

In all groups, specimens showed a certain degree of apical micro-leakage. Teeth that were obturated with Thermafil showed significantly greater micro-leakage than teeth filled with McSpadden thermomechanical technique and Schilder vertical compaction technique.

Group 1 (McSpadden) presented average of 1,934.40 µm, with 726.566 standard deviation. Group 2 (Schilder) presented average 2,083.20 µm with 1,328.713 standard deviation. Group 3 (Thermafil) presented 3,134.40 µm, with 877.247 standard deviation *(Table II)*.

Minimum value for group 1 was 432 and maximum was 2,784 µm micro-leakage. Group 2 presented minimum value of 384 and maximum 5,328 um. Group 3 presented minimum value 2,304 and maximum value 5,088 µm *(Table III)*.

A homogeneity test was applied. It showed that all 3 experimental groups were homogeneous.

When applying one factor ANOVA, the following was obtained: F = 4.191 and p = 0.026. Specifically, if we compare Thermafil and McSpadden we obtain p = 0.034, while when comparing Thermafil with Schilder we obtain p = 0.069.

At a later point, a non parametric variance analysis was applied, Kruskal-Wallis test, to ascertain the

Table I. Apical microleakage magnitude measured in µm.

McSpadden	Schilder	Thermafil
2,448	384	3,696
2,448	1,488	5,088
2,784	1,776	3,936
1,488	5,328	2,688
2,640	1,536	31,688
1,536	2,832	2,928
432	1,248	2,304
1,584	2,016	2,496
1,632	1,632	2,688
2,352	2,592	2,352

Table II. Microleakage average measured in µm and standard deviation.

	Average	Std. dev
McSpadden	1,934.40	726.566
Schilder	2,083.20	1,328.713
Thermafil	3,134.40	877.247

Table III. Microleakage minimum and maximum values measured in µm.

	Minimum	Maximum
Mc. Spadden	432	2,784
Schilder	384	5,328
Thermafil	2,304	5,088

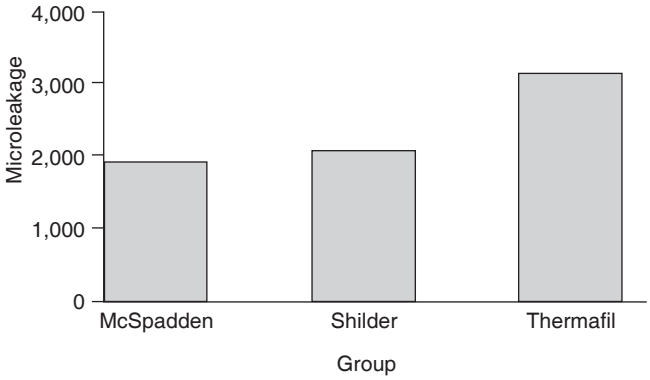

Figure 3. Apical microleakage of the three filling techniques.

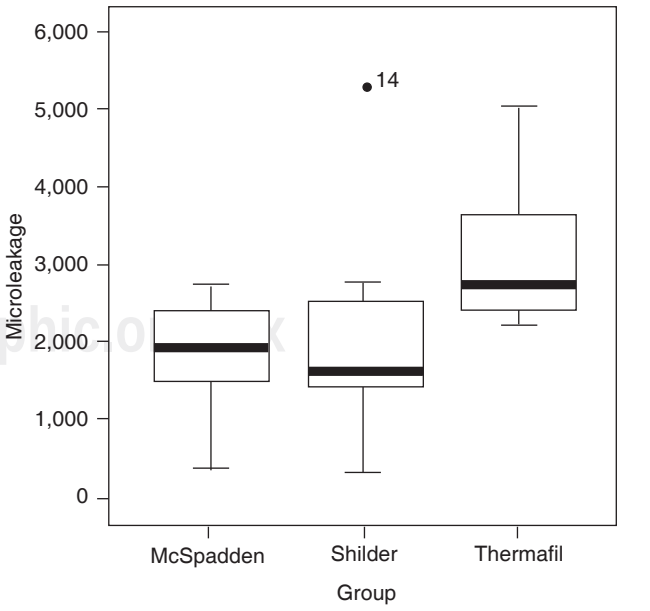

Figure 4. Apical microleakage of the three filling techniques.

previous results. Result showed that z = 9.094 and p = 0.011. Therefore, results equally showed a statistically significant difference in Thermafil micro-leakage amount when compared to McSpadden and Schilder. Thermafil presented greater degree of micro-leakage (Figures 3 and 4).

DISCUSSION

Dye penetration has been long used as an apical microfiltration assessment method. It is still greatly used although new methods have been developed. It has been found there was no significant statistical difference among them.[11,12] According to Ahlberg & co, better penetration is achieved when using methylene blue, when compared to any other type of dye.[13] Sealing capabilities of optimal condition root canal systems achieved by different sealing techniques have been studied. In these, the canal is prepared with instruments and filled without encountering any complication. This is the case for Xu Q & al. who assessed sealing capabilities of four different filling techniques. They found that techniques using thermally softened gutta-percha offer better results when compared to cold lateral compaction technique.[13]

Bousselta F & al assessed apical micro-leakage of three filling techniques: cold lateral compaction, thermo-mechanical filling, and a system with a Thermafil-comparable transporter covered with gutta-percha. He found that this last technique offered greater resistance to micro-leakage, when compared to the two former. No statistically significant difference was found between results of the two previously mentioned techniques.[15]

Pommel L & al did not find statistically significant differences in results obtained when filling with Thermafil and Vertical Compaction.[16] Nevertheless, Haikel & co observed better sealing capabilities when canals were filled with Thermafil than when filling canals following McSpadden technique.[17]

When comparing quality of filling provided by Thermafil as compared with vertical compaction, Bhambhani & al were unable to find statistically significant differences between results obtained with those two techniques.[18]

Saunders & al reported the fact that presence of a fractured instrument within the apical third of a given root canal bears no influence on the time required for bacterial invasion, when dealing with canals filled with lateral, cold compaction technique.[19] Mohammadi & al obtained similar results from a later study, where they concluded that a fractured instrument, by itself bears no influence on sealing capacity of the filling material.[10] Nevertheless, these results contradict those reported by Altundasar & al, who reported finding greater amounts of filtration in canals filled in the presence of fractured rotary instruments in the apical third, when compared to that found in canals filled with no presence of fractured instruments fragments.[20] In the present study, the apical sealing of two filling techniques, Thermafil and lateral cold compaction technique were assessed, in the presence of an instrument fractured at apical level. Results showed that when filling with Thermafil, more satisfactory results were obtained than those achieved by the lateral technique. With the first technique, lesser amounts of micro-filtration were found.

The present study assessed sealing capabilities of three filling techniques using thermally softened gutta-percha in the presence of an instrument fragment (Pro Taper F3 tip). The same method was used for placing sealing cement. In previous results it had been observed that canal filling must mainly be conducted with filling material. It was equally observed that better results were associated to lesser amounts of sealing cement.[21,22]

Results obtained in the present study indicate that the presence of a fractured instrument within the canal prevents reaching hermetic sealing of the canal. It was also found that better results were achieved when filling with techniques such as thermal-mechanical and vertical compaction when compared to filling with Thermafil. This can be due to the fact that the first two depend more on the operator´ s skill to conduct the obturation, and the third depends more on the commercial distributor, since, in this case, modifications are very hard to reach. Difficulty to ensure results can be related to not finding previous research with which to compare. For this reason, our research was based upon studies that showed that thermo-plasticized gutta-percha filling provided better sealing than that obtained with lateral compaction technique.[14]

Special care must be taken when clinically reporting these results, since, if there were to be a fractured instrument, the sealing of the filling represents only one of many factors that can affect treatment results.[20] It has been reported that presence of a periapical, radiolucid image is clinically more significant for an unfavorable prognosis than the presence of a fractured instrument.

CONCLUSIONS

Results obtained in the present study indicate that Thermafil filling technique presents less

effective sealing capabilities than those obtained with Thermo-mechanical McSpadden technique or Schilder's vertical compaction technique, when all three techniques are applied to a canal presenting a fragment of rotary instrument located at apical level. Thermo-mechanical and vertical compaction techniques allowed lesser dye penetration than Thermafil. Usage of these techniques can reduce risk of apical micro-leakage. Clinical relevance of this study must be carefully assessed, since results cannot be directly brought to clinical application level. More extensive future studies are needed to assess whether the difference between several filling systems bears direct influence upon the determination of success in canal therapy, as well as in studies which verify obtained results, since there are few similar studies.

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