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Full Length Research Paper

Evaluation of the amount of apically extruded debris using Mtwo and RaCe systems – An *in vitro* study

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Extrusion of debris into the periradicular tissue during endodontic treatment is one of the main causes of postoperative flare-ups. The aim of this study was to compare the amount of apically extruded debris using Mtwo instruments with single length technique and RaCe system using crown-down approach. 40 extracted mandibular premolar were included in this study. The teeth were decoronated to establish a length of 15 mm. The roots were placed through the holes cut in the lids of glass vials. The vials were weighed and the teeth were randomly assigned into two experimental groups of 20 teeth each. In the first group, the canals were prepared using RaCe rotary in a crown-down fashion. While in the second group, the canals were instrumented using Mtwo rotary with single length technique. After the instrumentation, the vials were heated to drive off all the moisture. The glass vials were weighed again, and the weight of extruded debris was calculated. Student t-test was used to compare the debris extrusion of experimental groups. The results show that both instruments tested produced a considerable debris extrusion. However, the Mtwo system with single length technique produced significantly more debris extrusion than RaCe system with crown-down technique.

Key words: Apical extrusion, debris extrusion, Mtwo system, RaCe system.

INTRODUCTION

Extrusion of debris into the periradicular tissue is one of the main causes of peri-apical inflammation and postoperative flare-ups (Seltzer and Naidorf, 1985). Therefore, it is logical to minimize the amount of apically extruded debris during instrumentation (Kustarci et al., 2008). All the instrumentation techniques produce some debris extrusion (McKendry, 1990; Al-Omari and Dummer, 1995; Azar and Ebrahimi, 2005). However, some techniques or systems tend to extrude less debris than the others (Torabinejad et al., 1985). A common finding is that the techniques which use rotational movement produce less debris extrusion than techniques using a pull-push motion (McKendry, 1990; Ferraz et al., 2001; Bidar et al., 2004; Kustarci et al., 2008), and rotary engine-driven systems tend to extrude less debris than hand techniques (Ferraz et al., 2001; Kustarci et al., 2008). Nickle-titanium (NiTi) rotary instruments vary in their design, cross section, and method of use (Elmsallati et al., 2009). Therefore, the amount of apically extruded debris may differ among them (Tanalp et al., 2006; Logani and Shah, 2008).

Most of the NiTi rotary instruments are used in a crown-down manner. By first enlarging the coronal portion of the canal, this approach provides a coronal escape way that reduces the amount of apically extruded debris (Fairbourn et al., 1987). One of the recently introduced rotary systems mainly used in this manner is the RaCe system (FKG dentaire, Switzerland). The flutes alternating with straight areas alongside the instrument reduce the “screw in” effect and improve coronal evacuation of the debris (Schafer and Vlassis, 2004). Recently, Mtwo system (VDW, Germany) has been introduced with different design and method of use. Unlike other modern NiTi systems, Mtwo is used with “single-length technique”, and all the instruments are taken to the full working length (Sonntag et al., 2007). As entire canal length is approached at the same time, this

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Table 1. Canal preparation sequences used in this study.

RaCe group	Mtwo group
0.10 taper size 40 (coronal 4 mm)	0.04 taper size 10 (to full working length)
0.08 taper size 35 (coronal 8 mm)	0.05 taper size 15 (to full working length)
0.06 taper size 30 (to 4 mm working length)	0.06 taper size 20 (to full working length)
0.06 taper size 25 (to full working length)	0.06 taper size 25 (to full working length)

technique has also been called “simultaneous technique” (Malagnino et al., 2006). In this technique, the coronal part of the canal is not enlarged prior to the apical portion. Therefore, the amount of the apically extruded debris by Mtwo system may be more than systems using conventional crown-down technique (Sonntag et al., 2007). On the contrary, the number and depth of the flutes in the Mtwo instruments differ from tip to handle with shallower flutes near the tip, which is claimed to increase the capacity to remove debris coronally (Malagnino et al., 2006).

Due to these different points of view regarding debris removal capacity of Mtwo, the present study was conducted to compare the amount of apically extruded debris using Mtwo instruments with single-length technique and RaCe system using crown-down approach.

MATERIALS AND METHODS

40 extracted human mandibular premolar with patent single canals and mature apices were included in this study. The soft tissue on the root surfaces was debrided with a periodontal curette. The teeth were radiographed to determine the specimen with minimal curvature of 0 to 10° root curvature using Schneider’s method (Schneider, 1971). Then, the teeth were decoronated with a diamond disk (Isomet, buehler, USA) under copious water spray to establish a uniform length of 15 mm. A size 20 k-file (Maillefer, Switzerland) was introduced into the canal to confirm patency and measure the canal length. The selected teeth met the criterion of similar canal diameter of 0.2 mm at the apical foramen. The working length was determined by subtracting 1 mm from this length.

Canal instrumentation and debris collection

The roots were placed through the holes cut in the lids of glass vials, and the interfaces were sealed with cyanoacrylate adhesive. The vials were weighed using a Mettler microbalance (Mettler Instrument, Switzerland) to 0.01 mg. The measurements were repeated three times, and the average value was calculated for each vial. The teeth were randomly assigned into two experimental groups of 20 teeth each. In the first group (RaCe group), the canals were prepared using RaCe rotary (FKG Dentaire, Switzerland) in a crown-down fashion (Table 1). While in the second group (Mtwo group), the canals were instrumented using Mtwo rotary (VDM, Germany) with single-length technique (Table 1). The rotary files were used in a 64:1 gear reduction air-driven contra-angle handpiece (NSK, Japan). Each file was used 5 to 10 s in the canal. The canals were irrigated with 1 ml of distilled water delivered by a syringe with 27-guage needle after each file use. The needle was placed as far as possible into the canal without binding. A size 10 k-file (Maillefer, Switzerland) was used to establish the apical patency. Instrumentation in both groups was performed by one operator. The glass vials were covered by rubber dam during instrumentation.

After the instrumentation, the debris adhered to the root apex was collected by washing off with distilled water into glass vials. The vials were stored in an incubator containing calcium chloride crystals in 68°C for a month to drive off all the moisture. The glass vials were weighed again three times, and the average value was calculated. The weight of extruded debris in each vial was calculated by subtracting pre-experiment weight of the vials from the weight of vials with dried debris, and the mean weight of extruded debris was calculated for each group.

Statistical analysis

The data were statistically analyzed using SPSS software Ver. 16 (SPSS Inc, Chicago, IL). Kolmogorov-Smirnov test was used to confirm the normality of the data. Student t-test was used to compare debris extrusion of experimental groups. P-values less than 0.05 were considered significant.

RESULTS AND DISCUSSION

The results show that both instruments tested produced a considerable debris extrusion. The Mtwo rotary system used with single-length technique produced more debris extrusion than RaCe system with statistically significant difference ($P<0.05$) (Table 2).

The present study was carried out to compare the amount of apically extruded debris using Mtwo versus RaCe system. A previously described method was used for debris collection (Elmsallati et al., 2009) except that we did not use an air vent to equalize the internal and external vial pressure. Several factors influence the debris extrusion (Sonntag et al., 2007; Kustarci et al., 2008; Logani and Shah, 2008; Elmsallati et al., 2009) such as irrigating method (Brown et al., 1995), amount of irrigating solution used (Vande Visse and Brilliant, 1975; Baugh and Wallace, 2005), final apical size of the foramen (Baugh and Wallace, 2005; Tinaz et al., 2005), anatomy of the apical constriction (Tinaz et al., 2005), instrumentation time (Tanalp et al., 2006), instrumentation technique (Kustarci et al., 2008), and the design of the instrument (Elmsallati et al., 2009). In the present study, all these variables were matched between groups except the instrument design and instrumentation technique. The initial apical size was matched by the placement of a size 20 k-file in the cana l (Tanalp et al., 2006). The final apical size was matched by using size

Table 2. Weight of debris extruded apically during instrumentation by each system.

Parameter	Rotary system	
	RaCe	Mtwo
Mean weight (mg)	0.34	0.61
Standard deviation	0.218	0.374
Range (mg)	0.10 - 0.90	0.20 - 1.40

25/0.06 as the final instrument in both methods. The type of tooth, root length and curvature, the type and amount of irrigant were all matched to reduce the variables during preparation. Only one tooth type with slight curvature was selected to eliminate the complications likely to happen in the instrumentation of severely curved root canals. The number of instruments used and the instrumentation time were also kept constant. We used distilled water as irrigant to avoid weight increase by mineral precipitate after evaporation of the irrigant. Various methods have been used to dry the debris before weighing. Al-Omari and Dummer (1995) kept the samples at room temperature for about one month. However, the moisture in the air might influence the final weight of the debris. In the present study, the samples were heated to dry off the moisture as described by Elham et al. (2009). All the instrumentation in the present study was confined to 1 mm short of the apical foramen, and apical patency was maintained during instrumentation to avoid dentin plug formation (Leonardi et al., 2007). A single operator prepared all the canals to eliminate the inter-operator differences.

As recommended by manufacturers, Mtwo system was used in a “single-length technique” with “brushing movement”; however, RaCe system was used in a “crown-down” manner with “pecking motion” (Ingle et al., 2008). The results show that Mtwo system caused significantly more debris extrusion than RaCe system ($p<0.05$). Moreover, this difference should not be attributed only to the instrumentation method because the design of the instruments is different, and the different debris extrusion is the result of both design and method of use. Direct comparison of the present data with those of other studies is difficult because of the differences in instrumentation method, final and initial apical size, and the different sequence used. Moreover, the results are limited to the mature teeth and should not be generalized to teeth with open apices. Another issue to be considered is that periodontal tissue and even granulation tissue in chronic apical periodontitis act as a natural barrier and limit the extrusion of debris and irrigants (Tanalp et al., 2006). Contrary to previous studies, we did not use an air vent to make a kind of resistance against debris extrusion. However, it does not completely simulate the resistance of natural barriers, and *in vitro* studies such as the present study are unable to precisely simulate the clinical conditions (Tanalp et al., 2006).

Another important matter regarding studies on debris extrusion is the clinical importance of the results. These studies mostly focus on the weight of the extruded debris; however, the amount of debris extrusion which is clinically important is unknown, and any amount of extruded debris is likely to create clinical problems (Elmsallati et al., 2009). The quality of the extruded debris is another issue that should be considered as a factor influencing the amount of extruded debris tolerated by the body (Al-Omari and Dummer, 1995). The type and virulence of extruded bacteria may be equally important (Al-Omari and Dummer, 1995). It is therefore prudent to minimize the extrusion of debris. However, further studies are required to elucidate the relative importance of quality and quantity of extruded debris and the amount of debris that is clinically important.

Conclusion

Within the limitation of this study, it was concluded that both Mtwo and RaCe system produced debris extrusion. However, Mtwo system with single-length technique produced significantly more debris extrusion than RaCe system with crown-down technique.

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