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COMPARATIVE EVALUATION OF THE AMOUNT OF DEBRIS EXTRUDED APICALLY USING CONVENTIONAL SYRINGE, PASSIVE ULTRASONIC IRRIGATION AND ENDOIRRIGATOR PLUS SYSTEM: AN IN VITRO STUDY

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ABSTRACT

Aim: The aim of this study is to compare the effects of conventional syringe, passive ultrasonic irrigation (PUI), and EndoIrrigator Plus on the amount of apically extruded debris. **Materials and Methods:** Thirty extracted human mandibular premolars were selected and randomly assigned to three groups ($n = 10$). The root canals were irrigated with conventional syringe, PUI, and EndoIrrigator Plus. Sodium hypochlorite was used as an irrigant, and debris was collected in a previously described experimental model (Myers and Montgomery 1991). It was then stored in an incubator at 37°C for 10 days to evaporate the irrigant before weighing the dry debris. The mean weight of debris was assessed, one-way analysis of variance was used for comparison of values, and post hoc Tukey's test was used between groups ($P = 0.05$). **Results:** The EndoIrrigator Plus group extruded significantly less debris than PUI and conventional syringe groups ($P < 0.05$). Furthermore, PUI group extruded significantly less debris than conventional syringe irrigation group ($P < 0.05$). **Conclusions:** 1. All the three irrigation systems were associated with apical extrusion of debris, 2. EndoIrrigator Plus system extruded significantly less debris than the PUI system and the conventional syringe irrigation system, 3. PUI system extruded significantly less debris than the conventional syringe irrigation system.

KEYWORDS: Apical extrusion; debris; EndoIrrigator Plus; passive ultrasonic irrigation.

INTRODUCTION

The success of endodontic treatment is dependent on thorough debridement of the root canals, and irrigation plays a vital role in it. Both disinfection and debridement are largely dependent on irrigation protocol used and has long been considered as an essential adjunct to instrumentation. However, in recent years, its importance has grown considerably (Gulabivala et al. 2005, Zehnder 2006, and van der Sluis et al. 2007), in view of the finding that a significant part of the root canal wall is left untouched by contemporary instrumentation techniques (Peters et al. 2001 and Paque et al. 2010, 2011).[1] During the use of endodontic instruments and irrigants, organic and inorganic debris, microorganisms, and irrigants may be extruded into the periradicular space causing postoperative inflammation, pain and a delay in healing. One of the most important complications related to or that occurs as a consequence of apical extrusion during root canal procedures is interappointment flare-ups and postoperative pain, which is an undesirable occurrence both for patients and clinicians (Tanalp and Gungor 2014).[2] Therefore, every effort should be made to reduce apical extrusion of infected debris so as to minimize postoperative reactions. The type of root canal irrigation system and the design of irrigation needles may also affect the frequency and amount of apically extruded debris (Mitchell et al. 2011).[2] The conventional syringe irrigation is the basic technique for root canal irrigation, and the depth of needle tip placement in the canal is the most dominating factor for solution penetration.[3] Passive ultrasonic irrigation (PUI) first used by Weller et al.[4], in 1980, utilizes ultrasonic wave energy that is transmitted from a file or smooth oscillating wire to the irrigant.[5] Recently, a new irrigant delivery system has been introduced (EndoIrrigator Plus; Innovations Endo, Nasik, India) which is based on the concept of continuous warm activated irrigation and evacuation system (CWAIS). This system consists of an inbuilt suction and heater with controlled positive pressure and apical negative pressure tips which are to be used with warmed sodium hypochlorite at a temperature of 45°C–50°C.[5,6] The effects of EndoIrrigator Plus on apical extrusion of debris have not been reported. Therefore, the aim of this study was to compare the effect of conventional syringe, PUI and EndoIrrigator Plus on the amount of apically extruded debris.

MATERIALS AND METHODS

Thirty freshly extracted human mandibular premolars were selected. The inclusion criteria were single-rooted teeth with one root canal and one apical foramen with a mature closed apex. Radiographs were taken from buccolingual as well as mesiodistal directions for the evaluation of root morphology. Soft-tissue remnants and calculus on the external root surface were removed mechanically. Access cavities were prepared in each tooth and the canal patency was established with a size 15 flexile file (Mani Inc., Tochigi, Japan).

The working length was determined by measuring the length of the initial instrument (size 15) at the apical foramen minus 1 mm. A single operator instrumented the canals of all specimens using flexile files up to apical size 40, using standard step back technique. Apical patency was maintained by passing a size 15 file to the working length after the use of each file. Thirty teeth were then randomly divided into three groups (n = 10) as follows:

Group A (conventional syringe irrigation): Irrigant was applied with a syringe and a 30-gauge closed-end tip and side-port opening needle (Canal clean, Biodent, South Korea). After the use of each instrument, the irrigation needle was placed 1 mm short of the predetermined working length and the canals were irrigated using 1 ml of 3% sodium hypochlorite for 1 min, and after the last instrument, 2 ml of sodium hypochlorite was used over a period of 2 min. •

Group B (Passive ultrasonic irrigation): The irrigation procedures in this group were performed using the same needle that was utilized in conventional syringe irrigation. After each irrigation, a Sonofile K-file ultrasonic tip (size 15, 0.02 taper) (Satelec, Acteon Group Dental, Mérignac, France) was placed 1 mm short of the working length and activated at a frequency cycle of 28–32 Khz/s for 1 min, and after the last irrigation it was used for 2 min. •

Group C (EndoIrrigator Plus): Here, warm sodium hypochlorite heated to 50°C was placed into the canal with the help of controlled positive pressure tip up to middle one-third of the canal. The positive pressure tip was used between each instrument for 1 min, and the canals were irrigated and simultaneously evacuated. After the last instrument, apical negative pressure tip was used by placing it 1 mm short of the working length and the canals were irrigated using warm sodium hypochlorite and simultaneously evacuated for 2 min.

This study was done in Dept of Conservative dentistry and Endodontics M.R Ambedkar dental college Banagolre in the year 2017-2018, after obtaining ethics committee approval. In this study, a previously described experimental model by Myers and Montgomery[7] in 1991 was used for debris collection. Eppendorf tubes with their own stoppers were weighed with an electronic weighing machine which had an accuracy of 0.0001gm. Three consecutive weights were obtained for each tube, and the average measurement was taken to be its initial weight. Separate rubber stoppers were made for each Eppendorf tube which fitted tightly to its opening end and holes were created on these rubber stoppers. Teeth were inserted up to the cementoenamel junction and fixed to these rubber stoppers with cyanoacrylate and a 21-gauge needle, which was placed alongside the rubber stopper to equalize the internal and external air pressure. These set-ups were then placed into preweighed Eppendorf tubes, and the tubes were fitted into vials. After the completion of instrumentation, each tooth with their corresponding rubber stoppers were removed from the Eppendorf tubes, and the debris adhering to the root surface was collected by washing the root surface with 1 ml of sodium hypochlorite in the Eppendorf tube. All root canal preparations were completed by one operator following which the Eppendorf tubes were numbered and a second examiner who was blind with respect to all experimental groups weighed the tubes. The tubes were stored in an incubator at 37°C for 10 days so as to evaporate the irrigant before weighing the dry debris. After the incubation period, the Eppendorf tubes with their stoppers were weighed three times using the same electronic weighing machine to obtain the final mean weight. The dry weight of the debris was calculated by subtracting the weight of the empty tube from that of the tube containing the extruded debris.

STATISTICAL ANALYSIS

The data were then analysed using ANOVA and Tukey's multiple post hoc tests at a significance level of $P < 0.05$. Statistical analysis was performed using the Statistical Package for the Social Sciences software package (SPSS Base 20.0 for Windows User's Guide, SPSS Inc., Chicago, IL, USA).

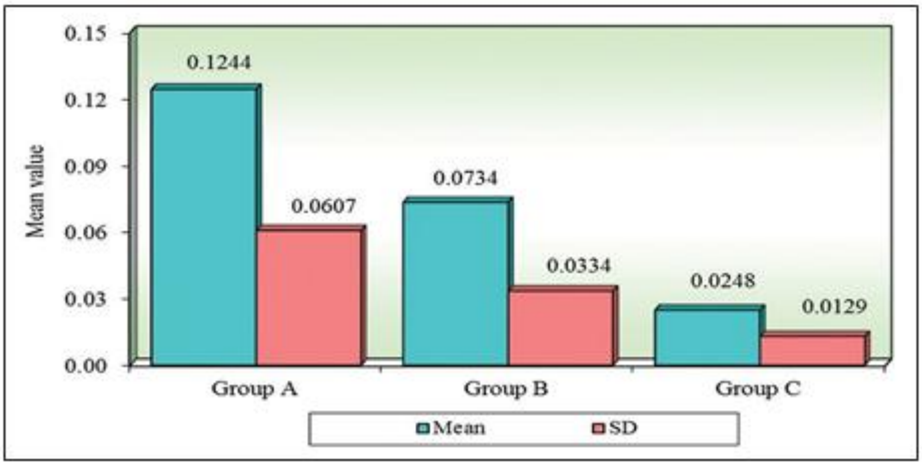

Figure 1: Comparison of weight of extruded dry debris in the three groups (A, B, and C).

Figure 2: Endo- irrigator Plus system.

RESULTS

Figure 1 shows the mean weight and standard deviation in the weight of apically extruded debris in the three groups. When the groups were compared using one-way ANOVA, there was statistically significant difference between Groups A, B, and C as ($P < 0.05$) [Table 1]. Tukey's multiple post hoc tests revealed that EndoIrrigator Plus group extruded significantly less debris than PUI and conventional syringe irrigation groups ($P < 0.05$). In addition, PUI group extruded significantly less debris than conventional syringe irrigation group ($P < 0.05$) [Table 2].

Table 1: Comparison of the weight of extruded dry debris in the three groups (A, B, and C) by one-way analysis of variance.

Sources of variation	Sum of squares	Degrees of freedom	Mean sum of squares	F	P
Between groups	0.0496	2	0.0248	15.0020	0.0001*
Within groups	0.0447 2	27	0.0017		
Total	0.0943	29			

Table 2: Comparison of the weight of extruded dry debris in the three groups (A, B, and C) by Tukey's multiple post hoc tests.

	GROUP A	GROUP B	GROUP C
MEAN	0.1244	P=0.0001*	0.0248
SD	0.0607	0.0334	0.0129
GROUP A			
GROUP B	P=0.0245*		
GROUP C	P=0.0001*	P=0.0326*	

*P<0.05 SD= STANDARD DEVIATION

DISCUSSION

Interappointment flare-ups during endodontic treatment is a true complication characterized by the development of pain, swelling or both.[8] Various types of injuries take place during preparation of the root canal which can lead to flare-up such as mechanical, chemical and/or microbial. Apical extrusion of infected debris to the periradicular space is possibly one of the principle causes of postendodontic treatment pain.[9] A study by Van de Visse and Brilliant (1975) to compare apical extrusion of debris in root canals with or without irrigation revealed that irrigation was a procedure that facilitated the extrusion of intracanal debris periapically and that instrumentation without irrigants resulted in no collectible debris.[10] Similarly, in the present study, three irrigation techniques were compared and the results revealed that they were all associated with apical extrusion of debris. However, as instrumentation alone cannot achieve complete elimination of bacteria and debris in all canals, effective irrigant delivery is a prerequisite for it.[11] Nowadays, the primary irrigant of choice is sodium hypochlorite (Zehnder 2006 and Dutner et al. 2012), mainly due to its unique tissue-dissolving capability (Moorer and Wasselink 1982, Zehnder et al. 2002, and Naenni et al. 2004) and strong antimicrobial effects, especially against biofilms (Arias-Moliz et al. 2009 and Bryce et al. 2009).[12] Therefore, sodium hypochlorite was used as an irrigant in this study. Furthermore, inadvertent extrusion of this caustic sodium hypochlorite can cause severe soft-tissue irritation and necrosis and can compromise the integrity of cancellous bone[13] therefore, its use should be restricted within the confines of the root canal system. The Endo Irrigator Plus group extruded significantly less debris compared with the PUI and conventional syringe irrigation groups. It is based on the concept of continuous warm activated irrigation and evacuation (CWAIS).[5,6] This device applies the principle of controlled positive pressure and apical negative pressure and supplies warm irrigant into the root canal system using single-use 30-gauge side-vented needles.[6] Here, controlled positive pressure is applied to the tip of the needle and simultaneously evacuated safely which may explain these results, as against irrigation with positive pressure which resulted in periapical extrusion (Myers and Montgomery 1991, Brown et al. 1995, Lambrianidis et al. 2001, and George and Walsh 2008).[2] Furthermore, its negative pressure tip sucks the irrigants placed into the pulp chamber down the root canal and back up again through the irrigation needle which may also explain these results. Using a similar design, Desai and Himel[14] and Gondim et al.[15] showed that an apical negative pressure technique (EndoVac) resulted in less irrigant extrusion and reduced postoperative pain. Previously, EndoVac also showed less extrusion of debris when compared with sonic irrigation systems such as EndoActivator and Vibringe though not significant.[2,11] In the present study, PUI group extruded less debris than the conventional syringe irrigation group, and this finding is in accordance with the result of a previous study by Tambe et al. 2013.[16] Previous studies showed that side-vented needles extruded less debris when compared with the regular irrigating needle[9],[17] Therefore, in the present study, closed-end tip and side-port opening needles were used for conventional syringe irrigation. Manual dynamic irrigation which uses a gutta-percha cone in short gentle strokes to activate the irrigant hydrodynamically was advocated by McGill et al. in 2008 to overcome the problem of apical extrusion of irrigant.[18] Therefore, further studies are needed to compare the efficacy of manual dynamic irrigation, EndoVac and other sonic irrigation systems such as Vibringe and EndoActivator with EndoIrrigator Plus system in reducing apical extrusion of debris. In the present study, an experimental model previously described by Myers and Montgomery in 1991 was used for debris collection. Others like Hachmeister et al.[19] and Altundasar et al.[16] suggested the use of foam, so as to simulate the back pressure provided by periapical tissues. However, this methodology has also been criticized as floral foam may absorb irrigant and debris while acting as a barrier.[16] The vital periapical tissues were not mimicked, so the results may not be same in an in vivo model. Therefore, it is not completely possible to extrapolate the results to the clinical situation.

CONCLUSIONS

1. All the three irrigation systems were associated with apical extrusion of debris.
2. EndoIrrigator Plus system extruded significantly less debris than the PUI system and the conventional syringe irrigation system.
3. PUI system extruded significantly less debris than the conventional syringe irrigation system.

REFERENCES

1. Boutsioukis C, Psimma Z, Kastrinakis E. The effect of flow rate and agitation technique on irrigant extrusion ex vivo. Int Endod J., 2014; 47: 487-96.
2. Karatas E, Ozsu D, Arslan H, Erdogan AS. Comparison of the effect of nonactivated self-adjusting file system, vibringe, EndoVac, ultrasonic and needle irrigation on apical extrusion of debris. Int Endod J., 2015; 48: 317-22.
3. Bronnec F, Bouillaguet S, Machtou P. Ex vivo assessment of irrigant penetration and renewal during the final irrigation regimen. Int Endod J., 2010; 43: 663-72.
4. Weller RN, Brady JM, Bernier WE. Efficacy of ultrasonic cleaning. J Endod, 1980; 6: 740-3.
5. Gadaalay S, Hariramani SI, Dhore P, Kale A, Agrawal M, Doshi S. Comparative evaluation of efficacy of three different irrigation activation systems in debridement of root canal isthmus: An in vitro study. Endodontology, 2017; 29: 39-42.
6. Neelakantan P, Devaraj S, Jagannathan N. Histologic assessment of debridement of the root canal isthmus of mandibular molars by irrigant activation techniques ex vivo. J Endod, 2016; 42: 1268-72.
7. Myers GL, Montgomery S. A comparison of weights of debris extruded apically by conventional filing and Canal Master techniques. Journal of endodontics, 1991 Jun 1; 17(6): 275-9.
8. Tanalp J, Kaptan F, Sert S, Kayahan B, Bayirl G. Quantitative evaluation of the amount of apically

extruded debris using 3 different rotary instrumentation systems. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2006; 101: 250-7.
9. Seltzer S, Naidorf IJ. Flare-ups in endodontics: I. Etiological factors. J Endod, 1985; 11: 472-8.
10. Tanalp J, Güngör T. Apical extrusion of debris: A literature review of an inherent occurrence during root canal treatment. Int Endod J., 2014; 47: 211-21.
11. Schilder H. Cleaning and shaping the root canal. Dent Clin North Am, 1974; 18: 269-96.
12. Yost RA, Bergeron BE, Kirkpatrick TC, Roberts MD, Roberts HW, Himel VT, et al. Evaluation of 4 different irrigating systems for apical extrusion of sodium hypochlorite. J Endod, 2015; 41: 1530-4.
13. Boutsioukis C, Psimma Z, van der Sluis LW. Factors affecting irrigant extrusion during root canal irrigation: A systematic review. Int Endod J., 2013; 46: 599-618.
14. Desai P, Himel V. Comparative safety of various intracanal irrigation systems. J Endod, 2009; 35: 545-9.
15. Gondim E Jr., Setzer FC, Dos Carmo CB, Kim S. Postoperative pain after the application of two different irrigation devices in a prospective randomized clinical trial. J Endod, 2010; 36: 1295-301.
16. Tambe VH, Nagmode PS, Vishwas JR, P SK, Angadi P, Ali FM, et al. Evaluation of the amount of debris extruded apically by using conv-entional syringe, endovac and ultrasonic irrigation technique: An in vitro study. J Int Oral Health, 2013; 5: 63-6.
17. Altundasar E, Nagas E, Uyanik O, Serper A. Debris and irrigant extrusion potential of 2 rotary systems and irrigation needles. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2011; 112: e31-5.
18. McGill S, Gulabivala K, Mordan N, Ng YL. The efficacy of dynamic irrigation using a commercially available system (Rinsendo) determined by removal of a collagen "bio-molecular film" fron an ex vivo model. Int Endod J., 2008; 41: 602-8.
19. Hachmeister DR, Schindler WG, Walker WA 3rd, Thomas DD. The sealing ability and retention characteristics of mineral trioxide aggregate in a model of apexification. J Endod, 2002; 28: 386-90.