Original Article

Comparative Evaluation of the Amount of Debris and Irrigants Extruded Apically by Different Irrigating Needles - An in vitro study

Neetu Mittal, Surinder Singh Chahal, Yogesh Kumar, Renu Aggarwal, Kanika Aggarwal

Department of Conservative Dentistry & Endodontics, Surendera Dental College & Research Institute, Sriganganagar, Rajasthan

Abstract:
Introduction: The main goal of the successful endodontics is the complete sterilization of the root canal space. During preparation, irrigants and debris such as bacteria, dentin fillings and necrotic debris may be extruded into the periradicular region leading to periapical inflammation and post-operative flare-ups. Several instrument designs and irrigation techniques have been developed to prevent this. Material and methodology: Fourty non carious extracted single rooted mandibular premolar teeth were divided into four groups of ten samples each depending upon the type of irrigating needles used i.e tip vented needles, side vented needles, ultrasonic tips & a control group with no irrigation used during instrumentation with K-files. The apically extruded debris and irrigating solution were collected in an apparatus made by using Myers and Montgomery technique and were measured quantitatively. The results were compared using a one-way ANOVA. A post hoc Tukey analysis and repeated measure test were used for multiple comparisons. Results: The mean weight of the extruded debris and irrigants for the three experimental groups was highest for the tip vented needles followed by side vented and then the ultrasonic tips. Conclusion: All the irrigation systems extruded the irrigating solution and debris. However, ultrasonic irrigating tips showed least apical extrusion.
Key words: Apical Extrusion, Side-vented needles, Tip-vented needles, Ultrasonic tips.

Corresponding Author Dr. Neetu Mittal, Department of Conservative Dentistry & Endodontics, Surendera Dental College & Research Institute, Sriganganagar, Rajasthan, E mail: drneetujindal@gmail.com

This article may be cited as: Mittal N, Chahal SS, Kumar Y, Aggarwal R, Aggarwal K. Comparative Evaluation of the Amount of Debris and Irrigants Extruded Apically by Different Irrigating Needles - An in vitro study. J Adv Med Dent Scie Res 2015;3(1):45-50.

INTRODUCTION

Cleaning and debriding the root canal system involves the removal of organic and inorganic debris. The organic debris includes the vital and necrotic pulp tissue, microorganisms, salivary or tissue fluids, endotoxins and other foreign components that have entered the root canal system. In contrast, the inorganic debris includes the minerals that are deposited in the canal system and debris deposited on the canal walls subsequent to instrumentation.[1,2] The irrigation of root canals with antibacterial solutions is considered an essential part of chemomechanical preparation.[3] Root canal irrigation is the key to cleaning and disinfecting the areas where the instrument cannot reach.[4] Irrigation with a syringe and a needle remains the most commonly used procedure.[5-9] In vitro studies have demonstrated that when root canals are instrumented and irrigated with patent apical terminations, extrusion of irrigants beyond the apical constriction is routine, which can be associated with pain, swelling, and tissue damage.[10,11]

An improved irrigation delivery system is highly desirable for effective root canal debridement. Such system should have adequate flow of irrigant to working length without forcing the solution into periapical tissues.[12] To increase the safety and efficiency of irrigation, different needle types, irrigation techniques and activation systems have been developed. Among these, new irrigation and activation systems, passive ultrasonic irrigation and apical negative pressure irrigation have been shown to promote an effective removal of debris and reduction of intracanal bacteria.[13] De Gregorio et al. [14] compared both systems and found that Apical Negative Pressure delivered the irrigant predictably to working length while Passive Ultrasonic Irrigation caused significantly more penetration of irrigant into lateral canals but not till working length. Studies have shown less extrusion with sonic or apical negative pressure devices compared with syringe and side-port needle.[2]

To understand the dynamics of apical extrusion of debris and irrigants from the root canal, various studies have been conducted in which different experimental set – ups simulating the clinical condition have been designed. The most commonly used method in various studies is the one proposed by Myers and Montgomery in 1991. The apparatus consisted of an instrumented root secured with a rubber stopper into a glass vial of 15x 45 mm which was placed into a glass flask with a rubber stopper fitted tightly on the mouth of the flask. A 25- gauge needle was placed alongside the stopper during the insertion to equalize the pressure inside and outside of the flask. The flask was then held securely in a rubber – jawed vise. The amount of extruded debris and irrigants is achieved by subtracting the weight of the collection vials after instrumentation and prior to it. To measure the amount of extruded irrigant specifically, the vial with the extruded material was placed next to a caliberated vial with 0.5ml increments of the irrigant used. The dry weight of the irrigants was calculated by placing the vials in a dessicator with $CaCl_2$ crystals.[15]

This in vitro study was aimed to compare the amount of debris and irrigating solution extruded apically by using the tip-vented needle, Side-vented needle and Ultrasonic tips.

MATERIAL AND METHOD

Fourty extracted human single-rooted mandibular premolar teeth were used in this study. The criterias for inclusion were: noncarious teeth, completely formed apices, single canal with single apical foramen, non-calcified canals, and canal curvature less than 20 degrees, which were determined according to Schneider's method.[15] The root end was inspected under magnification (X 20) to verify closed apices and the absence of root resorption or visible cracks. The teeth were radiographed from bucco-lingual and mesio-distal views to ensure that there was single canal and one orifice in each tooth. The teeth were then stored in saline till the experiment was started. Teeth were decoronated with a dimond disc to get equal length of root in all the samples (14mm). Forty samples were divided into four groups (n=10) depending on the irrigating needle used:

- Group A: No irrigation (control group, no irrigant used)
- Group B: Tip vented needles (NaviTip; Ultradent)
- Group C: Side vented needles (Calasept)
- Group D: Ultrasonic tips (woodpecker)

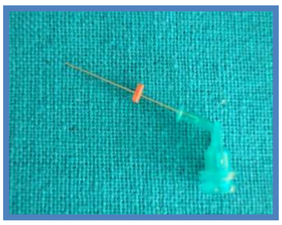


Figure 1: **Group B** **Group C** **Group D**

Test Apparatus: Empty gutta percha tubes were pre-weighed on a digital weighing machine (Mettlar PJ 3600) along with sponge piece. Two coats of nail varnish was applied on the external surface of roots except at the apical 2mm of the root. Each tooth sample was embedded on empty gutta percha tube with the help of stopper and wax leaving 2 mm of the coronal portion outside the stopper. A 22 gauge needle was bend and forced alongside the rubber stopper to keep the balance between the air pressure inside and outside the tubes. (Figure 2)

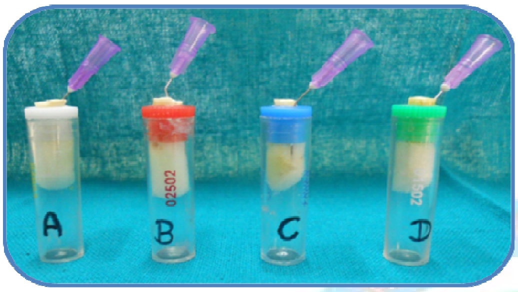


Figure 2: Test Apparatus

Root canal treatment*:* Debris and irrigant extruded from the apical foramen during instrumentation were collected using the Myers and Montgomery technique. The working length (WL) of each sample was determined by inserting a K-file size #15, which was observed to extend beyond the apical foramen and then subtracting 1 mm from the length of the file. BMP was done using crown down technique using ProTaper hand files and apex was prepared till size F3. In all the groups, 1ml of 5.25% sodium hypochlorite irrigant was used between the consecutive files, except for control group in which BMP was done without irrigant. On completion of the root canal preparation, the canals were dried with paper points, and the teeth were removed from the tubes. Full procedure was performed by a single operator.

Apical extrusion evaluation: After removing the tooth each gutta percha tubes were again weighed on the digital weighing machine after completion of instrumentation. (Figure 3) The amount of extruded debris and irrigating solution was then measured by subtracting the post-instrumentation weight from the pre-instrumentation weight and put to statistical analysis.

Figure 3: Weighing of the gutta percha tube after instrumentation

STATISTICAL ANALYSIS: The extend of apical extrusion of irrigants and debris by three different irrigating techniques was compared using a one-way ANOVA. A post hoc Tukey analysis and repeated measure test were used for multiple comparisons. The level of statistical significance was set at $P<0.001$.

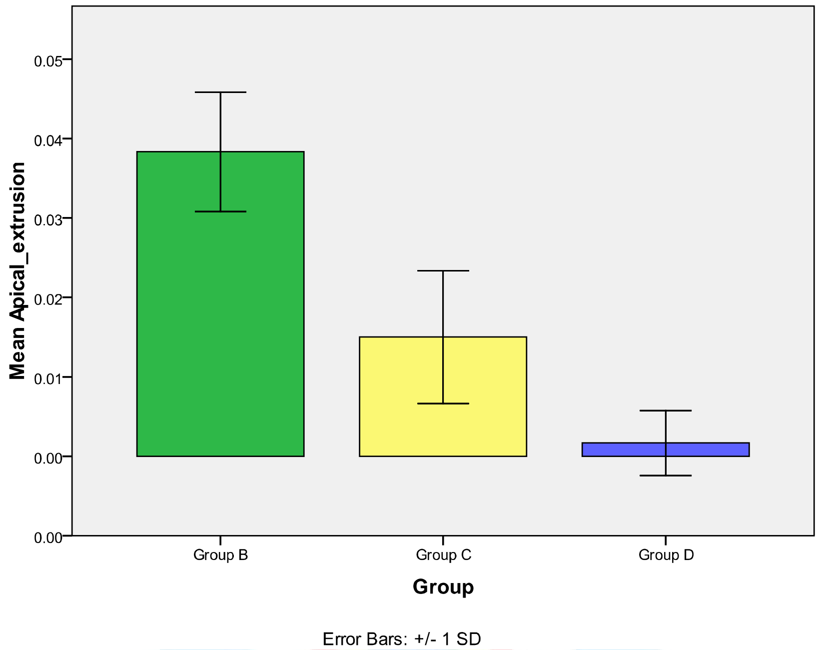
RESULTS

In the control group (no irrigant used) there was no difference in weight of the gutta percha tubes before and after instrumentation. All teeth in the three experimental groups were included in the extrusion analysis to calculate the mean weight difference for the extruded debris & irrigant. The mean weight of the extruded debris & irrigant for the three experimental groups was highest for the tip-vented group (0.038 ± 0.00753) followed by the side-vented group (0.15 ± 0.00837) and then the ultrasonic tip group (0.0017 ± 0.00408). Statistical analysis showed a significantly higher extrusion for the tip-vented and side-vented irrigation systems compared to the ultrasonic tip ($p<0.01$).The Tip-vented group also had a significantly higher extrusion compared to the side-vented group.

Table 1: Comparison of extruded debris & irrigant apically

Group	Apical Extrusion Mean ± SD	ANOVA	Inter Group Comparison#	P value
Group B	0.0383 ± 0.00753	F = 43.256;	Group B vs C	<0.001**
Group C	0.0150 ± 0.00837	P < 0.001**	Group B vs D	<0.001**
Group D	0.0017 ± 0.00408		Group C vs D	0.012*

#Post-Hoc Tukey; * p < 0.05; Significant; **p < 0.001; Highly Significant
Group A was Control group



Graph 1: Weight (Mean ± SD) for the extruded debris & irrgant for the tip-vented, side vented and ultrasonic tips.

DISCUSSION

This in vitro study was conducted to evaluate the extrusion of debris and irrigant in the apical area of the root with an ultrasonic tips compared to the tip-vented and side-vented needle irrigation systems. In the present study maximum apical extrusion was with tip vented needles followed by side vented and least by ultrasonic-tips.

The main objective of root canal therapy is to prevent and treat periradicular inflammation by eliminating microorganisms from the root canal system and preventing subsequent reinfection.[16] It has been shown that the root canal curvature and length can influence the amount of apical extrusion of debris. Therefore, in the present study only straight root canals (curve between 0–10) with similar lengths were used.[17] To simulate periapical tissue which may pose resistance to apical extrusion of debris, a piece of sponge was used.[15]

According to the results of the present study the tip vented needles showed highest amount of apical extrusion this may be due to increased amount of mean pressure exerted by these tips on the apical foramen thus leading to increased apical extrusion. Ultrasonic irrigation causes least amount of apical extrusion of debris and better canal cleanliness because ultrasonic activation causes agitation of the irrigation solution against canal walls and minimum amount of the pressure is exerted on the apical foramen.[18]

The side-vented group in our study produced less amount of apical extrusion & cleaner canals compared to the tip-vented group. The reported superior performance of the side-vented needle has been attributed to turbulence effect and greater distribution of irrigating solution because of their design. [19,20]

CONCLUSION

Within the limitations of the present study, all the irrigating systems extruded the debris and irrigants apically. Ultrasonic irrigating tips showed least apical extrusion of debris and irrigants followed by tip vented needles.

REFERENCES

1. Ribeiro EM, Silva-Sousa YT, Souza-Gabriel AE, Sousa-Neto MD, Lorencetti KT, Silva SR: Debris and smear removal in flattened root canals after use of different irrigant agitation protocols. Microsc Res Tech 2012; 75(6):781–790.
2. Desai P, Himel V: Comparative safety of various intracanal irrigation systems. J Endod 2009; 35(4):545–549.
3. Haapasalo M, Endal U, Zandi H, et al: Eradication of endodontic infection by instrumentation and irrigation solutions. Endod Top 2005; 10:77–102.
4. Haapasalo M, Endal U, Zandi H, Coil JM: Eradication of endodontic infection by instrumentation and irrigation solutions. Endod Top 2005; 10(1):77–102.
5. Ingle JI, Himel VT, Hawrish CE, et al: Endodontic cavity preparation. In: Ingle JI, Bakland LK, eds. Endodontics. 5th ed. Ontario, Canada: BC Decker; 2002:502.
6. Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. J Endod 2004; 30:559–67.
7. Senia ES, Marshall JF, Rosen S. The solvent action of sodium hypochlorite on pulp tissue of extracted teeth. Oral Surg Oral Med Oral Pathol 1971; 31:96–103.
8. Vande Visse JE, Brilliant JD. Effect of irrigation on the production of extruded material at the root apex during instrumentation. J Endod 1975; 1:243–6.
9. Ram Z. Effectiveness of root canal irrigation. Oral Surg Oral Med Oral Pathol 1977; 44:306–12.
10. Gernhardt CR, Eppendorf K, Kozlowski A, Brandt M: Toxicity of concentrated sodium hypochlorite used as an endodontic irrigant. Int Endod J 2004, 37(4):272–280.
11. Pashley EL, Birdsong NL, Bowman K, Pashley DH: Cytotoxic effects of NaOCl on vital tissue. J Endod 1985, 11(12):525–528.
12. Benjamin A. Nielsen. Comparison of the endovac system to needle irrigation of root canals. J Endod 2007; 33:1‑5.
13. Cohenca N, Silva LA, Silva RA, Nelson-Filho P, Heilborn C, Watanabe E, Saraiva MC.Microbiological evaluation of differe nt irrigation protocols on root canal disinf ection in teeth with apicalperiodontitis: an in vivo study. Braz Dent J. 2013; 24(5):467-73.
14. de Gregorio C, Estevez R, Cisneros R, Paranjpe A, Cohenca N. Efficacy of different irrigation and activation systems on the penetration of sodium hypochlorite into simulated lateral canals and up to working length: an in vitro study. J Endod 2010; 36:1216-1221.
15. Myers GL, Montgomery S. A Comparison of Weights of Debris Extruded Apically by Conventional Filing and Canal Master Techniques. J Endod 1991;17(6): 275-9.
16. Alkahtani A, Al Khudhairi TD, Anil S. A comparative study of the debridement efficacy and apical extrusion of dynamic and passive root canal irrigation systems. BMC Oral Health. 2014;14:12.
17. Schneider SW. A comparison of canal preparations in straight and curved root canals. Oral Surg Oral Med Oral Pathol 1971;32(2):271–275.
18. Prichard J: The effect of ultrasonic irrigation variables on the dimensions of artificial root canals. Dental Tribune,

United Kingdom Edition; 2012: April 9-15.

19. Howard RK, Kirkpatrick TC, Rutledge RE, Yaccino JM: Comparison of debris removal with three different irrigation techniques. J Endod 2011; 37(9):1301–1305.

20. Ribeiro EM, Silva-Sousa YT, Souza-Gabriel AE, Sousa-Neto MD, Lorencetti KT, Silva SR. Debris and smear removal in flattened root canals after use of different irrigant agitation protocols. Microsc Res Tech 2012 ; 75(6):781–790.

Source of funding: Nil

Conflict of interest: None declared