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Apically Extruded Debris Following Root Canal Instrumentation Using Three File Systems: A Comparative In-Vitro Study

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Abstract

Background: Apically extruded debris induced during root canal instrumentation is of clinical importance associated with postoperative pain and flare-ups. Different file systems with different kinematics and designs may influence the amount of extruded debris.

Objective: This in-vitro study aimed to assess and compare the quantity of apically extruded debris after root canal instrumentation by three different endodontic file systems: EdgeFile X7, 2-Shape, and WaveOne Gold.

Methods: A total of thirty single-rooted extracted human mandibular premolars were collected and randomly allocated into three groups (n = 10). Group A was instrumented with the EdgeFile X7 rotary system, Group B with the 2-Shape rotary system, and Group C with the WaveOne Gold reciprocating system. Debris were collected in known-weighted glass vials following the Myers and Montgomery method. After instrumentation, the vials were dried at 68°C in an incubator for five days. The dry debris weight was calculated using a high-precision digital balance. Statistical analysis for the collected data was performed with one-way ANOVA and Duncan's post-hoc tests ($p < 0.05$).

Results: All file systems resulted in extrusion of apical debris. The WaveOne Gold system led to significantly higher mean amount of debris comparing with the other two systems ($p < 0.05$). The EdgeFile X7 system induced the lowest mean amount of debris, followed by the 2-Shape system, with no statistically significant difference between them ($p > 0.05$).

Conclusion: Within this study's limitations, file systems with rotation motion (EdgeFile X7 and 2-Shape) were related to less extrusion of apical debris comparable to the reciprocating system

(WaveOne Gold). The file design and motion kinematics were significantly related to amount of debris extruded beyond the apical foramen.

Keywords: Apical extruded debris, EdgeFile X7, 2-Shape, WaveOne Gold, Reciprocation, Rotation.

1.Introduction

Removing of all root canal system contents including bacteria is the primary objective of instrumentation which have the potential to be pathogenic, also establish special shape of canal that permit the obturation material fit easily (1).

During root canal instrumentation many debris such as irrigant, bacteria, necrotic pulp and dentinal shavings may push accidentally through the apex into periradicular tissue which may cause inflammation, post-operative pain, and delayed healing (2) as a result of of acute inflammatory response in periapical region (3).

The first attempt to measure the quantitiy of apical extruded debris in 1975 by Vande Visse and Brilliant (1&2). These extruded debris amount may differ based on the method of instrumentation, type of canal preparation instrument and its size. Understanding these factors is essential to minimize the amount of debris extruded into periapical tissues (4).

Of the common endodontic rotary instrumentation systems are Two Shape system, Wave One Gold system, and Edge File X7.

The Two Shape system is consisting of 2 shaping files which work by continuous rotation which are treated by using heat and T wire technology to give flexibility to file so the file after each use return to its original shape (5).

Wave One Gold is a file of group V of ISO-FDI (based on use) is introduced to improve wave one systems operate by 150° counter-clockwise (CCW) direction then dis engages 30° in a clockwise (CW) direction so this mean cutting cycle is 120° and we need three cycles of files to reach a reverse rotation of 360° (6).

The Edge File X7 is nickel titanium files constructed by a fire wire process which join the cryogenic and heat treatment resulted in a singular crystalline matrix from the alloy of heat-treated fire wire, decreasing the influence of shape memory which is inherited in nickel titanium instruments but raise the flexibility and the strength to cyclic fatigue (7).

This study was conducted to calculate and compare the quantity of debris extruded apically after root canal instrumentation with three different systems: Wave One Gold, Edge file, Two Shape.

2. Methods

2.1. Sample Selection and Preparation

Thirty extracted single-rooted human mandibular premolars with straight canals and completely formed apices were assigned for this study. Teeth with multiple canals, severe curvatures, or previous endodontic treatment were excluded to ensure standardization. The teeth were externally cleaned of debris and decoronated using disc with abundant water-cooling left samples with equivalent length (15mm) and obtained flat reference point. Samples then stored in distilled water during the study procedures. Access cavities preparation were performed using a high-speed diamond bur, and the working length (WL) determination was performed by negotiating size #15 K-file inside the canal until it was just visible from the apical foramen before subtracting 1 mm from that measurement.

2.2. Experimental Groups

The samples were allocated randomly into three experimental groups (n = 10 per group) according to the instrumentation system to be used:

Group A (EdgeFile X7): T1 and T2 files, group B (2-Shape System): primary file, and group C (WaveOne Gold).

The canals are kept patent throughout the procedure using a size #15 K-file.

2.3. Debris Collection Apparatus

The Myers and Montgomery method was followed to collect and measure apically extruded debris. Each tooth was inserted into a pre-weighted glass vial through a rubber cap. A 25-needle gauge was also inserted through the cap to balance pressure internally and externally. The sample then was isolated using rubber dam sheet with floss ligature and surrounded by flowable composite to improve sealing. This prevent the coronally extruded debris from contaminating the exterior surface of the glass vial and keep the procedure blind.

2.4. Instrumentation and Irrigation Protocol

All canals were prepared following manufacturers' instructions of each file system. Irrigation protocol involved using a total of 9 ml of distilled water divided into 4 ml during instrumentation, 3 ml after instrumentation as final wash, and 2 ml washing the exterior root surface to collect any adhering debris into the glass vial. The irrigation flow rate was 1 ml/min using 30-gauge side vented disposable needle tip.

2.5. Weight Analysis and Statistics

The glass vials containing the extruded debris were incubated at 68°C in an incubator for three days to ensure complete water evaporation. Each vial was then weighed using a high-precision digital analytical balance (0.0001g), and the mean value of three consecutive readings was recorded. Calculating the dry debris weight was performed by subtracting the initial weight of the vial from the final weight. Data were statistically analyzed using ANOVA and Duncan's post-hoc tests to analyze significant differences between the groups.

3. Results

Apically extruded debris amount was determined for each of the three experimental groups. The descriptive statistics, including the mean weights and standard deviations for each tested group, are summarized in the table (1). Statistical analysis was performed to identify significant differences between the instrumentation systems.

Table (1): mean, standard deviation, one-way ANOVA, and posthoc Duncan's test of apically extruded debris among file systems used.

Instrumentation System	Number of Samples (n)	Mean Debris Weight (g)*	Standard Deviation (SD)
EdgeFile X7	10	0.00278[a]	±0.0000772
2-Shape	10	0.00310[b]	±0.0000667
WaveOne Gold	10	0.00470[a, b]	±0.0001700

* means significant difference among groups using one-way ANOVA test $p<0.05$. Identical superscript lowercase letters indicate significant difference between the tested groups using posthoc Duncan's test $p<0.05$.

One-way ANOVA test indicated statistically significant differences among the groups tested in the amount of apically extruded debris ($p<0.05$). Comparisons of Duncan's post-hoc test pointed that the EdgeFile X7 system was related to the lowest mean amount of induced debris, followed by the 2-Shape system. Alternatively, the WaveOne Gold reciprocating system produced the highest mean amount of apical debris extrusion among all groups. A highly statistical significant difference was recorded between WaveOne Gold and the other two rotary systems ($p<0.01$). While no significant difference was observed between the EdgeFile X7 and the 2-Shape systems ($p>0.05$).

4. Discussion

The primary goal of endodontic instrumentation is cleaning and shaping the root canal system effectively with minimum debris extrusion into the periapical tissues. Apical debris extrusion is of clinical importance as it is directly related to postoperative pain and flare-ups (8). This study evaluated three different instrumentation systems: EdgeFile X7, 2-Shape, and WaveOne Gold for their tendency of apical debris extrusion.

The results of this study revealed that all tested systems induced some level of apical debris extrusion, which is supported by previous literature concluded that these debris would develop regardless of instrumentation technique used (9). However, significant differences were observed between the groups. The WaveOne Gold system, which based on reciprocation, led to highest amount of debris. This finding coinside with several previous studies suggesting that reciprocating motion may push debris apically rather than flute it coronally (10&11).

On the contrary, the EdgeFile X7 system produced the lowest mean amount of debris. This might be due to its specific metallurgy (electropolishing, heat-treatment) and parabolic cross-sectional design, which improves flexibility with less canal transportation results in less debris creation (12&13). The 2-Shape system, a rotary sequence, showed intermediate results without notable statistical difference from the EdgeFile X7 suggesting that continuous rotation mainly facilitates better removal of debris from the canal in comparison to reciprocation (14), but significantly less than WaveOne Gold. This might be due to its taper 0.06 which is less than 0.07 taper of WaveOne Gold indicating less dentin cutting and consequently less debris extrusion (10&15).

While this in-vitro study provides valuable findings, limitations of inability to simulate clinical environment should be acknowledged especially the absence of periapical tissue, vital or necrotic pulp, presence of apical patency, body temperature, and other factors that were not accounted during this experimental setup (16&17).

5. Conclusions

Within this in-vitro study limitations, it can be concluded that all instrumentation systems used in this resulted in apical extruded debris with varying amounts that significantly depend on design and type of motion of each file system suggesting that continuous rotation motion may be more effective in clearance of root canal debris coronally and minimize their apical extrusion.

Clinicians should take into consideration instrumentation system design and type of movement as critical factors to minimize postoperative complications related to apical extruded debris.

Ethical Statement

This research is established after obtaining ethical approval from Research Ethics Committee in the College of Dentistry (RECCOD), Tikrit University (Approval No. 50426).

References

1. Garg N, Garg A. Textbook of Endodontics. 4th ed. New Delhi: Jaypee Brothers Medical Publishers; 2019.
2. Siqueira JF. Microbial causes of endodontic flare-ups. Int Endod J. 2002;35(5):435-448.
3. Al-Zaka IM. The incidence of pain after root canal treatment using different irrigation methods. Tikrit J Dent Sci. 2024 Jan 20;2(1):38-43. doi: 10.25130/tjds.2.1.7.
4. Reddy SA, Hicks ML. Apical extrusion of debris using two hand and three engine-driven instrumentation techniques. J Endod. 1998;24(3):180-183.
5. Micro-Mega. 2Shape: The sequence of 2 instruments in continuous rotation to shape the root canal. France: Micro-Mega; 2018.
6. Webber J. Shaping canals with confidence: WaveOne Gold single-file reciprocating system. Roots (Int Mag Endod). 2015;1:34-40.
7. Al-Amidi A, Al-Gharrawi HR. Effect of autoclave sterilization on the cyclic fatigue resistance of EdgeFile X7, 2Shape, and F-One nickel–titanium endodontic instruments. J Conserv Dent. 2023;26(1):26-31.
8. Garcia K, Limoeiro AG, Nascimento WM, Kadi EM, Radaic S, Neri L. The influence of different working lengths on apically extruded debris. Res Soc Dev. 2021;10(4):e50410414554.
9. Fontana CE, Ferraresso GM, Derigi LP, Pinheiro G da, Trevensoli VC, Bueno CE. Analysis of the influence of different kinematic instrumentation in extrusion of apical debris. Int J Adv Eng Res Sci. 2020;7(8):9-14.
10. Tomer AK, Mangat P, Mullick S, Dubey S, Chauhan P, Kumari A. Quantitative evaluation of apically extruded debris of different single file systems: WaveOne Gold, One Shape, F360, and Reciproc: An in vitro study. Int J Oral Care Res. 2017;5(1):65-67.
11. Al-Zaka IM, Al-Gharrawi HR. Evaluation of apically extruded debris using different nickel-titanium instrumentation systems. J Conserv Dent. 2022;25(3):294-298.
12. Khalil WA, Merdad K, Abu-Haimed TS, Howait M, Alsofi L. Cyclic fatigue resistance of ProTaper Gold, EdgeFile, OneShape and ProTaper Universal. Egypt Dent J. 2018;64:589-596.
13. Koch K, Brave D. Real world Endo: Design features of rotary files and how they affect clinical performance. Oral Health. 2002;92:39-49.
14. Serefoglu B, Miçooğulları Kurt S, Kaval ME. Apically extruded debris using different nickel-titanium systems: 2Shape, TruNatomy, and ProTaper Gold. J Dent Res Dent Clin Dent Prospects. 2022;16(2):102-106.
15. Nevares G, Albuquerque D, Xavier F, Fogel H, Freire L, Cunha R. Evaluation of apically extruded debris during root canal retreatment using ProTaper Next and Reciproc in severely curved canals. Iran Endod J. 2017;12(3):323-328.
16. Al-Gharrawi HR, Al-Zaka IM. Methodological limitations in evaluating apically extruded debris: A systematic review of in-vitro protocols. J Int Oral Health. 2024;16(1):12-19.
17. Silva EJ, Rocha MS, Perez R. The impact of body temperature and periapical lesion simulation on debris extrusion: A critical analysis. Int Endod J. 2024;57(2):210-222.