

## Influence of Root Canal Preparation with Different Tapers on Apical Leakage

Remy Barazy<sup>1\*</sup>, George Eshoa<sup>2</sup>

1. MSC, DDS, Department of Endodontics, Faculty of Dentistry, Aleppo University.

2. Asso prof, PhD, MSc, DDS, Department of Endodontics, Faculty of Dentistry, Aleppo University.

### Abstract

To compare the influence of root canal preparation Tapers on apical sealing ability, using two rotary Ni-Ti systems and stainless-steel hand instruments.

Forty-five mesial canals (buccal or lingual) of extracted permanent mandibular molars were selected and divided into three groups. The root canals were instrumented using stainless steel hand instruments, Hero Shaper .04 system, and Revo S .06 system. All canals were obturated with the continuous wave compaction technique and thermoplastic Gutta-Percha injection technique.

Dye penetration method was used to evaluate apical leakage using stereomicroscope at 20X magnification. Results were subjected to statistical analysis.

No statistically significant difference was found among the groups prepared with rotary systems. While, significant difference was found between rotary Ni-Ti/ Hand SS groups.

Under the conditions of this study, root canal preparation with tapers .04 and .06 showed the least apical leakage compared to hand instrumentation.

**Experimental article (J Int Dent Med Res 2020; 13(2): 486-490)**

**Keywords:** Taper; Rotary; Apical leakage; stainless steel; Ni-Ti.

**Received date:** 03 November 2019

**Accept date:** 09 December 2019

### Introduction

The essential goal of endodontic therapy is to keep the involved teeth healthy and functional in the oral cavity. Success rates of endodontic treatment is up to 86-98%.<sup>1</sup>

This success can be accomplished by the biomechanical preparation that aims to achieve a continuously tapered canal form while preserving the integrity and location of the canal and apical anatomy in preparation for an adequate obturation and furthermore reduces microorganisms in the root canals.<sup>2,3</sup>

Brunson et al<sup>4</sup> demonstrated that the increase of root canal dimensions leads to an increase in the mean volume and efficacy of irrigants. And that can be achieved by increasing the final apical preparation size and/or its taper.<sup>5</sup> So, Taper is a factor that determines final root canal dimensions and successively, the space for the cleaning action of irrigants.<sup>6</sup>

There is numerous advantages of tapered root canal preparations over the apical stop preparation<sup>6</sup>.

These advantages are:

- 1- enhanced cleaning ability.<sup>7</sup>
- 2- improved instruments apical control.<sup>8</sup>
- 3- more reliable apical resistance form (apical seat), and greater dependability of cone fit.<sup>9</sup>
- 4- appropriate for all filling techniques.<sup>10</sup>

Many researchers believe that apical preparation should be as narrow as possible while increasing the instrument's taper (fixed or variable)<sup>11</sup>. The use of instrumentation large taper cuts a larger amount of dentin from the canal walls, which produces a cleaner root canal, creates a greater space for irrigation, and reduces the preparation errors and eases the root canal obturation.<sup>6,12</sup>

This theory appears to be sensible, However, it has minimal scientific evidence; it is not yet confirmed that using larger tapers leads to cleaner root canals.<sup>6</sup>

Therefore, the purpose of the present study was to investigate the influence of taper on apical leakage, which was assessed by the use of two different rotary systems (Revo S, Hero Shaper) and stainless-steel hand files.

#### \*Corresponding author:

Remy Barazy  
Department of Endodontics,  
Faculty of Dentistry, Aleppo University, Syria.  
E-mail: remybarazy92@gmail.com

## Materials and methods

Forty- five mesial (buccal or lingual) canals of extracted first or second lower molars were used in this study. Before preparation, all teeth were radiographed to ensure:

1. No previous endodontic treatment.
2. No root or pulp chamber caries
3. No absorptions, fractures or cracks.
4. Moderate curvature angle (10-20°)
5. Root development is complete.
6. No calcifications.
7. Buccal and lingual mesial canals are separated from orifice to foramen (Weine Type III).

Tissue fragments and calcified debris were removed by scaling, and the teeth were stored in 10% formalin (CH<sub>2</sub>O) (AlSa'ad pharma, Aleppo, Syria). At the time of the study, the teeth were washed with distilled water to remove residual formalin.

After access opening, canal length was determined by placing no. 10 files into each canal until the file was visible at apical foramen. The roots were randomly divided into 3 experimental groups (n = 15). Root canal instrumentation was performed with stainless steel hand files, Hero Shaper and Revo S and rotary systems (MicroMega, France) placed in the hand piece of Root ZXI motor (J-morita USA) with programmed torque control and speed settings.

Different protocols were used in a way that final root canal taper was 0.02, 0.04, and 0.06 for groups A, B and C, respectively. The instrumentation details were as follows:

**Group A:** Canal preparation was performed using stainless steel k-files taper 2%. Instrumentation begins with no. 15 file then enlarged to no. 25. Between every file change, patency at working length was confirmed by using no. 10 K-file, and the canals were irrigated with 2.5% sodium hypochlorite (NaOCl) (AlSa'ad pharma, Aleppo, Syria). Irrigation was performed with a 27-gauge blind-ended endodontic irrigation needle.

The volume of irrigant flushed after each file was 2 mL for all groups. The final irrigation sequence was 5 mL of 17% ethylenediaminetetraacetic acid (EDTA) (prevest-

denpro, Jalandhar, India) for 3 minutes, followed by 5 mL of 2.5% NaOCl and 5 mL saline solution.<sup>13</sup>

**Group B:** Canal preparation was performed using Hero Shaper rotary system. The instrumentation began with file 20/0.06 placed at the coronal and middle thirds of the canal followed by file 20/0.04 to the full length, file 25/0.06 to coronal and middle thirds of the canal and finished the preparation using file 25/0.04 to the full working length of the canal. The irrigation was performed just as described at group A.

**Group C:** Canal preparation was performed using Revo S rotary system. The instrumentation started with file SC1 (no. 25/0.06) placed at two thirds of the working length, followed by file SC2 (no. 25/0.04) and file SC (no. 25/0.06) to the full working length. The irrigation was performed just as described at group A.

After instrumentation, mesial and distal roots of each teeth were split longitudinally using a diamond disk in a buccolingual direction and only mesial roots were used. All canals were obturated using the endo-seal (Meta Biomed, Korea) root canal sealer, continuous wave compaction technique and thermoplastic Gutta-Percha injection technique.

After obturation, all roots were coronally sealed by glass ionomer cement (kavitan Pro, SpofaDent, Czech Republic). Then they were incubated at 37 C° and 100% humidity for 7 days to allow the sealing materials to set completely.

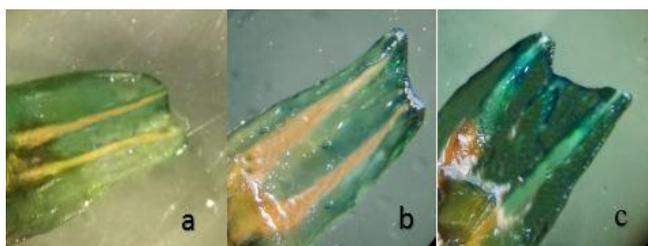
The roots were immersed in Pelican blue dye (Pelican ink 4001 PH=2.7, Germany), and stored in an incubator for 48 hours<sup>14</sup>. Then, the roots were cleared for the apical leakage study. The liner extent of dye penetration from the apical root ends was measured in millimeters by a stereomicroscope at (X 20) magnification<sup>14</sup>, using the Escobar criteria:<sup>15,16</sup>

0: No leakage, if penetration of the dye is 1.5 mm or less through the apical terminus; as shown in fig.1a.

1: Slight leakage, if penetration is up to 3 mm into the canal; as shown in fig.1b.

2: Moderate leakage, if penetration is more than 3 mm into the canal; as shown in fig. 1c.

The data were subjected to statistical analysis.



**Figure 1.** Leakage using Escobar's criteria (stages a, b, and c by turn)

### Results

The following Table shows the data of apical leakage extent in millimeters and by Escobar guidelines.

	Group A: Stainless Steel 2%		Group B: Hero Shaper 4%		Group C: Revo S 6%	
	Millimeters	Escobar	Millimeters	Escobar	Millimeters	Escobar
1	1.2	0	2.7	1	0.1	0
2	3.5	2	0.3	0	0.4	0
3	0.9	0	1.8	1	0	0
4	3.3	2	1	0	0	0
5	4.1	2	0.5	0	0.9	0
6	2	1	2.5	1	2.5	1
7	4	2	1.2	0	1.9	1
8	2.7	1	1.3	0	1.1	0
9	1.3	0	1.4	0	0.8	0
10	3.4	2	0.6	0	0.6	0
11	3.3	2	0.4	0	2.3	1
12	1.1	0	1.2	0	0.6	0
13	2.2	1	1.1	0	0	0
14	4.2	2	1	0	0.7	0
15	5.1	2	1.9	1	1.1	0

**Table 1.** The data of apical leakage extent in millimeters and by Escobar.

### Apical leakage

Descriptive data that included mean, standard deviation and range were obtained for each group and one-way ANOVA has performed followed by Bonferroni test to find any significant difference among the groups. A P-value of less than 0.05 was considered for statistical significance.

Groups	No.	Leakage in millimeters			Differences between groups		
		Mean	SD	Range	Groups compared	Mean diff.	P-value
A: Stainless Steel, 2%	15	2.82	1.31	0.9-5.1	A-B	1.56	.001
B: Hero Shaper, 4%	15	1.26	0.71	0.3-2.7	A-C	1.95	.000
C: Revo S, 6%	15	0.86	0.8	0-1.7	B-C	0.39	.993

**Table 2.** Statistical values on apical leakage in millimeters.

### Apical leakage by Escobar

Number of samples and percentage of leakage degree were obtained for each group using the Escobar guidelines. Kruskal wallis has been performed, and followed by Mann-Whitney

test to find any significant difference among the groups. A P-value of less than 0.05 was considered for statistical significance.

Groups	No.	Leakage by Escobar			Differences between groups		
		No. leakage	Slight leakage	Moderate leakage	Groups compared	Mann-Whitney Z score	P-value
A: Stainless Steel, 2%	15	4	3	8	A-B	3.092	.002
B: Hero Shaper 4%	15	11	4	0	A-C	3.293	.001
C: Revo S, 6%	15	12	3	0	B-C	0.424	.671

**Table 3.** Statistical values on apical leakage by Escobar.

The statistical analysis of both methods of measurements has indicated that group A prepared by stainless steel hand files shows significantly greater leakage extent than groups B and C prepared by Ni-Ti rotary systems.

At the same time, group B prepared by Hero Shaper 4% produced more leakage than group C prepared by Revo S, 6%.

### Discussion

One of the main criteria's in root canal preparation is the development of a continuously tapered form while keeping the original canal shape.<sup>17</sup>

This study evaluated the influence of three tapers of root canal preparation instruments (Revo S 6%, Hero Shaper 4%, and hand instrument K-files 2%) on apical leakage with the use of methylene blue dye penetration technique.

Results revealed that using Revo S and Hero Shaper rotary instrumentation produced significantly cleaner canals than the hand K-files. This finding is thought to highlight the advantages of using Ni-Ti rotary instruments, which produce a well tapered root canal form adequate for obturation, and due to greater flexibility of Ni-Ti; it maintains the canal curvature even in severely curved root canals.

These results were consistent with other studies, presenting significant difference between preparing root canals using stainless steel hand files and rotary Ni-Ti systems.<sup>2,18,19</sup>

The literature also indicates that using rotary Ni-Ti systems creates more circular and homogeneous canal shapes. And produces significantly increased root canal diameter, volume and surface area when compared with the manual technique<sup>20</sup> While, stainless steel instruments create more uninstrumented

regions.<sup>2</sup>

The ability of sealing the apical third of canal presented by Revo S and Hero Shaper rotary systems is similar to one another. The findings of the present study were consistent with other studies presenting no significant difference among different Ni-Ti systems.<sup>18,19,21-23</sup>

However, Hero shaper 4% showed slightly more apical leakage compared to Revo S 6%. And that can be explained by the rotary circumferential filing of Hero Shaper instruments that leaves noninstrumented areas at the apical third<sup>24</sup>, and the triple helix cross section in Hero shaper files, compared to the asymmetric cross section and progressive pitch in Revo S files<sup>25</sup>.

This provides less stress on the instrument and increases the available volume for upward debris elimination and more efficient cleaning<sup>26</sup>. It can also be explained by the fact that enlarging the root canal taper increases the disinfectious action, improves sealing ability and results in less voids; confirmed by many studies.<sup>27-29</sup>

On the other hand, Tabrizzadeh et al<sup>30</sup> indicated that reducing the preparation size may lead to a less apical leakage.

According to Germain et al<sup>31</sup>, the final taper of preparation is critical in sealing ability of obturating materials. And the apical adaptability of endodontic obturating materials increases when using larger preparation tapers.

In addition, studies proved that minimally treated root canals are less apically disinfected due to the lack of bacterial elimination and irrigant penetration compared with enlarged ones.<sup>32</sup>

In addition, according to Lee et al and Al Khalagi et al<sup>12,33</sup>, the diameter and taper of root canal have influenced the effectiveness of ultrasonic irrigation to remove artificially placed dentine debris.

## Conclusions

In the current study, the use of larger tapers in root canal preparation resulted in less apical leakage, but with no significant difference between taper 4% and 6%.

Despite, the use of hand instrument K-files showed more leakage than the NiTi rotary instrument (Revo S, Hero Shaper).

## Acknowledgments

This manuscript has not been published and is not considered for publication elsewhere. We have no conflict of interest to disclose.

All authors have made substantive contribution to this study and/or manuscript, and all have reviewed the final paper prior to its submission and publication of articles is supported by Aleppo University, Syria.

## Declaration of Interest

The authors report no conflict of interest.

## References

1. Alshaarani F, Barnkggei I, Jouy E, Elias K. Itching Gingiva: An Early Sign of Pre-Inflam-matory Pulp Necrosis or Unsuccessful Endodontic Treatment-A Case Series. *Int J Oral Dent Health* 2018;4(2):63.
2. Koçak MM, Yaman SD. Comparison of apical and coronal sealing in canals having tapered cones prepared with a rotary NiTi system and stainless steel instruments. *Journal of oral science* 2009;5(1):103-07.
3. Ayyad N, Saleh ARM. Comparison of the Shaping Ability of Reciprocating Single-File and Full-Sequence Rotary Instrumentation Systems in Simulated Canals. *Journal of International Dental and Medical Research* 2019;12(1):22-30.
4. Brunson M, Heilborn C, Johnson DJ. Effect of apical preparation size and preparation taper on irrigant volume delivered by using negative pressure irrigation system. *Journal of endodontics* 2010;36(4):721-24.
5. Sanghvi Z, Mistry K. Design features of rotary instruments in endodontics. *The Journal of Ahmedabad Dental College and Hospital* 2011;2(1):6-11.
6. Arvaniti IS, Khabbaz MG. Influence of root canal taper on its cleanliness: a scanning electron microscopic study. *Journal of endodontics* 2011;37(6):871-74.
7. Boutsioukis C, Gogos C, Verhaagen B, et al. The effect of apical preparation size on irrigant flow in root canals evaluated using an unsteady Computational Fluid Dynamics model. *International endodontic journal* 2010;43(10):874-81.
8. Gergi R, Rjeily JA, Sader J, Naaman A. Comparison of canal transportation and centering ability of twisted files, Pathfile-ProTaper system, and stainless steel hand K-files by using computed tomography. *Journal of Endodontics* 2010;36(5):904-07.
9. Khateeb SU, Kaul K, Kaul R, Jeri SY. Comparative study for determination of Root Canal working length accuracy by different methods—an in vivo/in vitro study. *IP Annals of Prosthodontics & Restorative Dentistry* 2017;3(3):88-93.
10. Hata G-i, Baba T, Toda T. Radiographic evaluation of root canals prepared by various nickel-titanium rotary file systems and obturated by the warm gutta-percha method. *Journal of Osaka Dental University* 2006;40(1):61-65.
11. Hassan A, Munshi I, Tootla S. Comparison of the effect of fixed and variable taper on the volume of obturation material. *South African Dental Journal* 2019;74(1):8-12.
12. Akhlaghi NM, Dadresanfar B, Darmiani S. Effect of master apical file size and taper on irrigation and cleaning of the apical third of curved canals. *Journal of Dentistry (Tehran, Iran)* 2014;11(2):188.
13. Alhadi D, Jaber FM, Agha MT, Saeed MH. The Effect of Diode Laser Irradiation on Root Canal Dentin. *Journal of International Dental and Medical Research* 2019;12(1):49-53.

14. El Sayed MAAM, Al Hussein H. Apical dye leakage of two single-cone root canal core materials (hydrophilic core material and gutta-percha) sealed by different types of endodontic sealers: An in vitro study. *Journal of conservative dentistry: JCD* 2018;21(2):147.
15. Kassar SA, Habib AA, Doumani MD, Abdulrab S, Alafif H. Evaluation of apical sealing ability of ActiV GP/glass ionomer sealer as a root filling material. *Endodontology* 2018;30(2):113.
16. Escobar C, Michanowicz AE, Czonstkowsky M. A comparative study between injectable low-temperature (70° C) gutta-percha and silver amalgam as a retroseal. *Oral Surgery, Oral Medicine, Oral Pathology* 1986;61(5):504-07.
17. Thompson S, Dummer P. Shaping ability of HERO 642 rotary nickel–titanium instruments in simulated root canals: Part 1. *International Endodontic Journal* 2000;33(3):248-54.
18. Ismail SA, Zakaria NA, Sultan MA. The Effect of Two Endodontic Rotary Systems in Root Canal Preparation on Apical Microleakage. *Al-Rafidain Dental Journal* 2013;1(17):37-43.
19. Leonardo MR, Cervi DdA, Tanomaru JMG. Effect of different rotary instrumentation techniques and thermoplastic filling on apical sealing. *Journal of Applied Oral Science* 2004;12(1):89-92.
20. Stavileci M, Hoxha V, Görduysus MÖ, et al. Effect of endodontic instrumentation technique on root canal geometry. *Journal of International Dental and Medical Research* 2017;10(3):952-57.
21. Tomer A, Banerjee S, Bhardwaj G. Comparative Evaluation of Apical Microleakage of Various Obturation Techniques using Single Cone Gutta-percha, Lateral Condensation, Obtura, Calamus and Thermafil by Dye Penetration Method. *International Journal of Oral Care and Research* 2016;4(1):4-7.
22. Taşdemir T, Er K, Yildirim T. Comparison of the sealing ability of three filling techniques in canals shaped with two different rotary systems: a bacterial leakage study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 2009;108(3):129-34.
23. Kim J-H, Lee K-H, Lee S-J. Effect of canal tapering in teeth of various apical size & cross-sectional configuration on microleakage. *Restorative Dentistry and Endodontics* 2005;30(2):95-101.
24. Maharti ID, Nursasongko B, Sumawinata N. No Difference in Root Canal Instrumentation of the Apical Third Between Reciproc® and Waveone®. *Journal of International Dental and Medical Research* 2017;10(S):793-99.
25. Gökürk H, Yücel A, Şişman A. The shaping ability of five different nickel-titanium rotary instruments in simulated root canals. *Atatürk Üniversitesi Diş Hekimliği Fakültesi Dergisi* 2014;24(1):58-66.
26. Fayyad DM, Sabet NE, El-Hafiz E-SMA. Computed tomographic evaluation of the apical shaping ability of Hero Shaper and Revo-S. *Endodontic Practice Today* 2012;6(2):119-24.
27. Ozkocak I, Sonat B. Evaluation of effects on the adhesion of various root canal sealers after Er: YAG laser and irrigants are used on the dentin surface. *Journal of endodontics* 2015;41(8):1331-36.
28. Zogheib C, Hanna M, Pasqualini D, Naaman A. Quantitative volumetric analysis of cross-linked gutta-percha obturators. *Annali di stomatologia* 2016;7(3):46.
29. Garrido A, Lia R, França S, et al. Laboratory evaluation of the physicochemical properties of a new root canal sealer based on Copafiera multijuga oil-resin. *International Endodontic Journal* 2010;43(4):283-91.
30. Tabrizzadeh M, Kazemipoor M, Hekmati-Moghadam S-H. Impact of root canal preparation size and taper on coronal-apical micro-leakage using glucose penetration method. *Journal of clinical and experimental dentistry* 2014;6(4):e344.
31. Germain S, Meetu K, Issam K. Impact of the root canal taper on the apical adaptability of sealers used in a single-cone technique: a micro-computed tomography study. *J Contemp Dent Pract* 2018;19(7):808-15.
32. Ruddle C. FOCUS on: minimally invasive endodontics. *Dentistry today* 2014;33(4):14.
33. Lee SJ, Wu MK, Wesselink P. The efficacy of ultrasonic irrigation to remove artificially placed dentine debris from different-sized simulated plastic root canals. *International Endodontic Journal* 2004;37(9):607-12.