

Original Research Article

Comparative study of vertical root fracture resistance of mandibular incisors and molars following canal-preparation with hand k-file and Revo-S rotary system

Shervin Bagherieh*, Mohammad Mehdi Bahrani, Milad Saffaripour

Student Research committee, Faculty of dentistry, Isfahan University of medical science, Isfahan, Iran

***Corresponding author**

Shervin Bagherieh

Email: shervinbgh@yahoo.com

Abstract: The purpose of current study was to compare vertical root fracture (VRF) resistance of mandibular incisors and first molars following root canal preparation with hand k-file and Revo-S rotary file. 26 mandibular incisors (a1 and a2 subgroups) and 26 mandibular molars (b1 and b2 subgroups) were divided into 4 groups, each group contained 13 similar teeth. Crown of these teeth were cut off 2 mm to Cementoenamel junction and they were kept in distilled water. Root canals of a1 and b1 subgroup were prepared by hand files and canals of a2 and b2 sub groups were prepared by Revo-S rotary system. Then #35 spreader was pushed into root canals using instron testing machine until fracture happened and the force causing fracture was recorded. Data were analyzed using SPSS/PC 23 with one way ANOVA test. There was no significant relationship between occurrence of VRF and preparation instrument ($P > 0.05$) but mandibular incisors showed less resistance to fracture than molars ($P < 0.05$). Incisors and molars were mostly fractured mesiodistally and buccolingually respectively. Due to easier and faster instrumentation with Revo-S files and same fracture rate with hand files it seems reasonable to use these files, although mandibular incisors should be prepared gently and more carefully due to higher fracture rate.

Keywords: Root canal preparation; Vertical root fracture; Revo-S rotary file

INTRODUCTION:

Vertical root fracture (VRF) which contains all of dentin thickness from within the canal to the periodontium can occur anywhere between height of tooth crown to tip of root apex [1]. VRF can be caused by many reasons such as corrosion induced expansion of inter canal posts, over pressuring of posts inside canals, wedging effect of inlays and over pressuring when obturating the canal using lateral condensation method [2,3]. In addition to that some studies suggest that decrease in dentin thickness from canal preparation can increase the chance of VRF happening in the after procedures [4]. Whatever the reason may be VRF cannot have a good prognosis [5]. In some cases (in multi-rooted teeth) the fractured root is cut off and the tooth is survived but in most cases extraction is the only possible solution [6].

Development of rotary nickel titanium files in recent years has revolutionized thoughts surrounding canal preparation [7]. In comparison with hand files preparing canals using rotary files decreases preparation errors like ledge formation, transportation and perforation while preparing the canals faster [8,9]. although there are some differences in remained dentin thickness of teeth prepared by students and more experienced clinicians there are other evidences

showing that cleaning the canals with rotary files can be more efficient [9,10]. Lam *et al.*; in their study showed that file design can affect the resistance and amount of remained dentin [11]. There are some other studies showing that canal preparation can weaken the root canal system and this weakening happens more often when using instruments of well-known brands [12, 13].

Revo-S rotary system (Micromega, Besancon, France) which has recently been introduced uses three files to clean and shape the canal and three optional files to enlarge the apical portion of the canal. These files have asymmetrical cross section which is claimed by manufacturer, that this design improves cleaning and shaping and facilitates negotiation of curved canals and reduces stress on tooth structure [14, 15].

Aim of this study is to compare vertical root fracture resistance of mandibular incisors and molars following canal preparation with hand k-files (Mani, Tochigi, Japan) and Revo-S rotary system.

METHODS AND MATERIALS:

This is an in vitro and interventional study. Human mandibular incisors and molars that were extracted for routine reasons were first stored in 10% formalin for two weeks and then they were kept in

distilled water until the experiment. Teeth surfaces were cleaned using ultrasonic scalers and then they were checked with naked eye for any immature apex, micro cracks on root surface, decays involving the root and short, narrow and curved roots. Teeth with these details were excluded from the study. 52 slightly curved teeth (26 incisors and 26 molars) were chosen for further experiment and divided into four groups. (n=13)

Group 1: teeth prepared with hand files
 Subgroup a1: 13 mandibular incisors
 Subgroup b1:13 mandibular molars

Group 2: teeth prepared with Revo-S system
 Subgroup a2: 13 mandibular incisors
 Subgroup b2: 13 mandibular molars

Canal preparation:

Crowns of the teeth were cut off using a diamond bur from 2mm to the CEJ which allowed direct access to the curve of canal for preparation, obturation and fracture resistance test. Sufficient working length was measured by number 8 hand k file 0.5 mm to the apex. Reference points in all teeth were flat surfaces of crowns. Then each group was prepared in order below.

Group1: preparing a1 and b1 subgroups using hand stainless steel files and step-back method:

A1 teeth canals and mesial root of b1 teeth were prepared using hand files to the number 30 as master apical file and then number 2 and 3 Gates Glidden burs were used for shaping coronal part of canals. Eventually these procedures were followed by using next five files after master apical file while decreasing 1mm of working length after using each file. Recapitulation and irrigation of canals were done after each step using 5.25% sodium hypochlorite.

Group2: preparing a2 and b2 subgroups using Revo-S rotary system:

Electrical micro-motor was set on speed of 350 RPM and maximum torque of 0.8 Ncm. a2 teeth canals and mesial canals of b2 teeth were prepared using Revo-S system's SC1 (#25 file 6% taper) with sweeping passive motion until two third of working length was shaped, then canal's patency was checked with a number 8 file and it was irrigated with 5.25% sodium hypochlorite after that the canal was again

prepared to the working length with SC2(#25 file 4% taper) file and patency was checked and irrigation was done again. Then the working length was shaped with SC3 (#25 file 6% taper) file. To equalize the situation for all 4 groups, AS30 file was used to shape a2 and b2 subgroup's canals.

Both groups were then put in water to avoid any dehydration.

Obturation:

All canals were dried with paper points before obturating. Prepared canals were then filled with gutta percha points (Aria dent, Tehran, Iran) and AH26 sealer (DENTSPLY, Ballaigues, Switzerland) using lateral condensation method. Gutta perchas were cut off 2mm to CEJ for that positioning the spreader vertically would be easier.

Mounting and fracture resistance measurement:

All teeth were mounted in putty (President, Colte`ne AG, Switzerland) and number 35 spreaders (Mani, Tochigi, Japan) were put vertically inside root canals. Spreaders were connected to instron testing machine (Model 5544, Instron Corp., Canton, MA) and the machine was running at the speed of 1 mm/min and they were gradually pushed in gutta perchas until the fracture happens. The load of fracture was recorded at kilogram force.

Statistical Analysis:

Data were analyzed using the SPSS/PC 23 (Chicago, IL) software package. One-way ANOVA was performed to compare the fracture loads generated in all four groups. Post-hoc comparisons using the Tukey HSD test were carried out to test differences among groups with a significant result. All statistical analysis was performed at the 95% level of confidence.

RESULTS:

Mandibular incisors show less resistance to VRF than mandibular molars in both preparation techniques (p<0.05). Preparing root canals with Revo-S rotary system doesn't makes tooth more susceptible to VRF than manual technique (p>0.05) (figure 1 and table 1). All samples showed root fracture on one side of the root (100%). Most of root fractures were buccolingually oriented in molars mesio-distally oriented in incisors. (Table 2)

Table 1: Vertical root fracture resistance in all groups by (Kg)

Group	Number of samples	Lowest	Highest	Average±SD
A1	13	1	8	4.00±2.00
B1	13	3.6	12	8.03±2.87
A2	13	1.3	9	4.58±1.87
B2	13	4	11.7	8.17±2.61

Table 2: Orientation of vertical root fractures

Group	Number of samples	Bucco-lingual	Mesio-distal
A1	13	4(31%)	9(69%)
B1	13	8(61%)	5(39%)
A2	13	3(23%)	10(77%)
B2	13	9(69%)	4(31%)

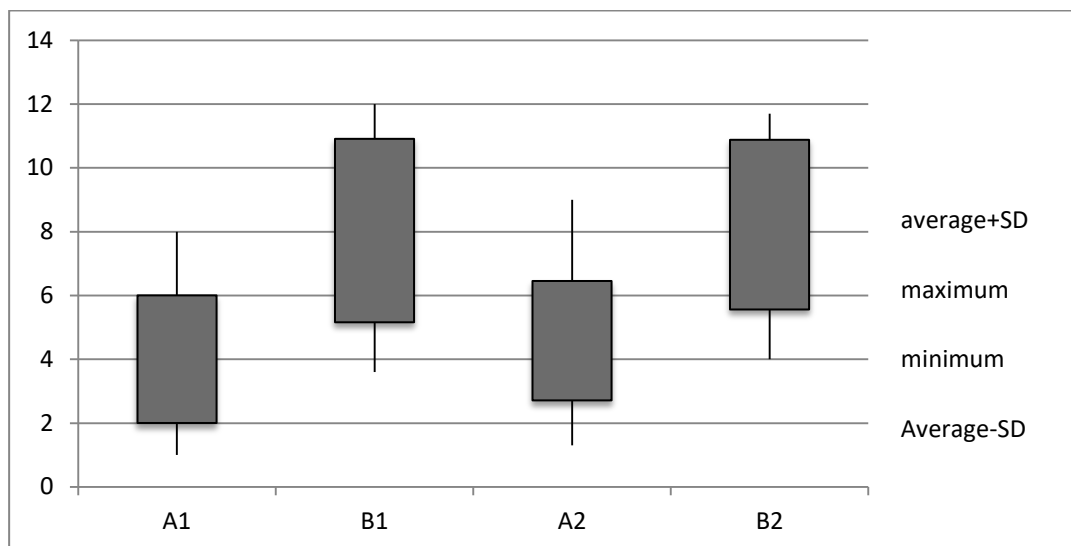


Fig 1: Highest, lowest and average force which caused VRF (kg).

DISCUSSION:

Developing rotary files has made endodontic treatments faster and easier, but there are still some concerns about removing dentin more than it is needed while using rotary files. Evidences for this idea had not clearly answered this question. Milani *et al.*; showed that preparing canals with manual technique makes the root more susceptible to VRF than protaper rotary system, whereas Abbaszadegan *et al.*; and Yoldas *et al.*; concluded that protaper rotary system create more micro cracks in dentin and makes root more susceptible to VRF [16-18].

Current study like Hedge *et al.*; and Ghodousi *et al.*; and Zare *et al.*; studies couldn't find any statistically significant different between occurrence of VRF in rotary and manual preparation techniques [19-21].

Studies discussed above suggest that preparing root canals with protaper systems makes root more susceptible to VRF than Revo-S rotary system and RACE system, perhaps because of higher torque protaper system needs to clean. In this study all crowns were cut off to gain straight line access. Using high speed hand piece for cutting teeth may create micro cracks in teeth but both groups have same situations for the possible cracks.

Lam *et al.*; showed that most fractures in mandibular molars are bucco-lingually oriented while Sathorn *et al.* showed that most fractures in mandibular

incisors are mesio-distally oriented which supports findings in the current study[11,22].

CONCLUSION:

What was found suggests that preparing root canals with Revo-S rotary system doesn't make teeth more susceptible for VRF than manual technique. Also cleaning and shaping teeth with rotary files is easier and faster so it is reasonable to use these files for cleaning and shaping in vivo.

REFERENCES:

- Schetritt A, Steffensen B; Diagnosis and management of vertical root fractures. J Can Dent Assoc. 1995; 61(7):607-13.
- Meister F, Lommel TJ, Gerstein H; Diagnosis and possible causes of vertical root fractures. Oral Surg Oral Med Oral Pathol. 1980; 49(3):243-53.
- Lertchirakarn V, Palamara JE, Messer HH; Load and strain during lateral condensation and vertical root fracture. J Endod. 1999; 25(2):99-104.
- Testori T, Badino M, Castagnola M; Vertical root fractures in endodontically treated teeth: A clinical survey of 36 cases. J Endod. 1993; 19(2):87-90.
- Oliet S; Treating vertical root fractures. J Endod. 1984; 10(8):391-6.
- Onnink PA, Davis RD, Wayman BE; An in vitro comparison of incomplete root fractures associated with three obturation techniques. J Endod. 1994; 20(1):32-7.
- Peters OA, Schonenberger K, Laib A; Effects of four Ni-Ti preparation techniques on root canal

- geometry assessed by micro computed tomography. *Int Endod J.* 2001; 34(3):221–30.
8. Deplazes P, Peters O, Barbakow F; Comparing apical preparations of root canals shaped by nickel-titanium rotary instruments and nickel-titanium hand instruments. *J Endod.* 2001; 27(3):196–202.
 9. Peru M, Peru C, Mannocci F, Sherriff M, Buchanan LS, Pitt Ford TR; Hand and nickel-titanium root canal instrumentation performed by dental students: A micro-computed tomographic study. *Eur J Dent Educ.* 2006; 10(1):52–9.
 10. Gluskin A.H, Brown DC, Buchanan LS; A reconstructed computerized tomographic comparison of Ni-Ti rotary GT??? Files versus traditional instruments in canals shaped by novice operators. *Int Endod J.* 2001; 34(6):476–84.
 11. Lam PPS, Palamara JE A, Messer HH; Fracture strength of tooth roots following canal preparation by hand and rotary instrumentation. *J Endod.* 2005; 31(7):529–32.
 12. Adorno CG, Yoshioka T, Suda H; The Effect of Root Preparation Technique and Instrumentation Length on the Development of Apical Root Cracks. *J Endod [Internet]. Elsevier Ltd; 2009; 35(3):389–92.*
 13. Bier CAS, Shemesh H, Tanomaru-Filho M, Wesselink PR, Wu MK; The Ability of Different Nickel Titanium Rotary Instruments To Induce Dentinal Damage During Canal Preparation. *J Endod [Internet]. American Association of Endodontists; 2009; 35(2):236–8.*
 14. Bürklein S, Börjes L, Schäfer E; Comparison of preparation of curved root canals with Hyflex CM and Revo-S rotary nickel–titanium instruments. *International endodontic journal.* 2014;47(5):470-6.
 15. Basrani B, Roth K, Sas G, Kishen A, Peters OA; Torsional profiles of new and used revo-s rotary instruments: an in vitro study. *Journal of endodontics.* 2011;37(7):989-92.
 16. Milani AS, Froughreyhani M, Rahimi S, Jafarabadi MA, Paksefat S; The effect of root canal preparation on the development of dentin cracks. *Iran Endod J* 2012; 7(4): 177-82.
 17. Abbaszadegan A, Sadat Aleyasin Z, Sedigh Shamsi M, Shahriari SH; Comparison of the effect of canal preparation by step back technique using hand instruments and gates glidden drills with protaper universal rotary system on the root resistance to vertical fracture. *J Shahid Sadoughi Univ Med Sci* 2013; 21(2): 247-56.
 18. Yoldas O, Yilmaz S, Atakan G, Kuden C, Kasan Z; Dentinal microcrack formation during root canal preparations by different NiTi rotary instruments and the self-adjusting file. *J Endod* 2012; 38(2): 232-5
 19. Hegde MN, Shetty SH, Godara N; Evaluation of fracture strength of tooth roots following canal preparation by hand and rotary instrumentation- An invitro study. *J Endodontol* 2008; (1): 22-9.
 20. Ghodousi J, Zebarjad S, Moradi S, Jalil zadeh tehrani H; comparing the dental root biomechanical properties following two different methods of instrumentation and obturation. *J Mashhad Dent School* 2008; 31(4): 299-306.
 21. Zare Jahromi M, Mirzakouchaki P, Mousavi E, Navabi AA; Fracture strength of mesiobuccal roots following canal preparation with hand and rotary instrumentation: an in vitro study. *Iran Endod J* 2011; 6(3): 125-8.
 22. Sathorn C, Palamara JE, Messer HH; A comparison of the effects of two canal preparation techniques on root fracture susceptibility and fracture pattern *J Endod* 2005; 31(4): 283-7