Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/5716
DOI URL: http://dx.doi.org/10.21474/IJAR01/5716

RESEARCH ARTICLE

INFLUENCE OF SPEED ON MICROCRACKS IN ROOT DENTIN DURING ROOT CANAL PREPARATION WITH TWO ROTARY SYSTEM-PROTAPER UNIVERSAL AND REVO-S.

Dr. Remya Elizabeth Mathew, Dr. S.Vidhyadhara Shetty and Dr. Harish Shetty.

Manuscript Info

Manuscript History

Received: 24 August 2017
Final Accepted: 26 September 2017
Published: October 2017

Abstract

Introduction: The aim of the present study was to observe the influence of speed on cracks in root dentin using the ProTaper system and Revo S system at low, medium and high speed.

Method: 36 mandibular premolar teeth that had been extracted for different reasons were selected. The teeth were decoronated and were divided into two groups-Group 1-ProTaper system (n-18) and Group 2-RevoS system (n-18). In group 1, 6 roots were shaped at 250rpm, 6 roots were shaped at 300rpm and 6 roots were shaped at 350rpm. Similar procedure was followed for group 2 at 250, 300,350rpm. After root canal procedure, all roots were sectioned horizontally at 3, 6,9mm from apex and were examined under stereomicroscope for presence of cracks. A Z test was used for data analysis. The significant level was set at $P<0.05$.

Results: At 350rpm more percentage of microcracks were observed for both groups when compared to speed at 250 and 300rpm and at 300rpm both systems showed less incidence of cracks. RevoS system showed fewer incidences of cracks at high speed when compared to ProTaper system.

Conclusion: In this in vitro study, instrumentation of root canals with RevoS at high speed made teeth less susceptible to cracks when compared to ProTaper system and 300rpm seems to be reasonable speed to use both these rotary files for cleaning and shaping in vivo with fewer incidence of cracks.

Introduction:-

Root canal preparation is one of the most important steps in any root canal treatment(1). For many years, root canal preparation was performed using stainless steel hand endodontic files (2). Today, clinicians have access to many newly developed nickel-titanium (NiTi) rotary instruments. These systems are preferred because of their various advantages, such as saving time and better cutting efficiency (3, 4). However,instrumentation with rotary NiTi instruments can potentially cause cracks in the root dentin (5–8). Dentinal cracks or root fractures occur when the tensile stress in the root canal wall exceeds the tensile stress of dentin (9). Rotary NiTi files with large tapers can produce increased friction and stresses on the canal wall and cause dentinal cracks in root dentin (6).

The ProTaper rotary instruments have a convex triangular cross-sectional design and a non-cutting safety tip. The basic series of ProTaper files comprise six instruments: three shaping and three finishing files. According to the manufacturer, the auxiliary shaping file SX should be used to produce more shape in the coronal portion of the root

Corresponding Author:- Remya Elizabeth Mathew.
Address:-yenepoyadentalcollege,deralakatte,mangalore-575018

canal. The shaping file S1 should be used initially up to 4mm short of the apex and the shaping files S1 and S2 throughout the working length to progressively enlarge the apical third. The finishing files (F1, F2 and F3) should be used to complete the apical third of the root canal.(10)

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.(11)

Both systems are used in the speed range of 250-350rpm as recommended by the manufacturer.(12,13). To the best of our knowledge, there are no current data on influence of speed of rotary system on micro crack formation in root dentin.

Thus the purpose of this study is to investigate the influence of speed on micro cracks in root dentin during the root canal preparation with 2 rotary system ProTaper Universal and Revo-S.

Materials and Methods:-

Selection Of Specimens:-

36 single rooted premolars were selected and stored in purified water. Teeth with curved roots, calcified canals,extra canals, and teeth with developmental anomaly or resorption were excluded from the study. The teeth were decoronated at coronal portion by using a diamond disc leaving roots approximately of 10mm in length All the roots were inspected with transmitted light for detecting any pre-existing cracks or any craze-lines by using a stereomicroscope under ×12, to exclude teeth with such findings from this study.

Distribution Of Specimens To The Groups:-

Patency of the canal was established using a #10 K-File(Mani, Japan) in the canal. The specimens were then divided into two groups; each group containing 18 specimens each.

GROUP 1:-ProTaper Universal (18)
SUBGROUP A1-6 teeth at 250rpm
SUBGROUP B1-6 teeth at 300rpm
SUBGROUP C1-6 teeth at 350rpm

GROUP 2:-Revo S (18)
SUBGROUP A2-6 teeth at 250rpm
SUBGROUP B2-6 teeth at 300rpm
SUBGROUP C2-6 teeth at 350rpm

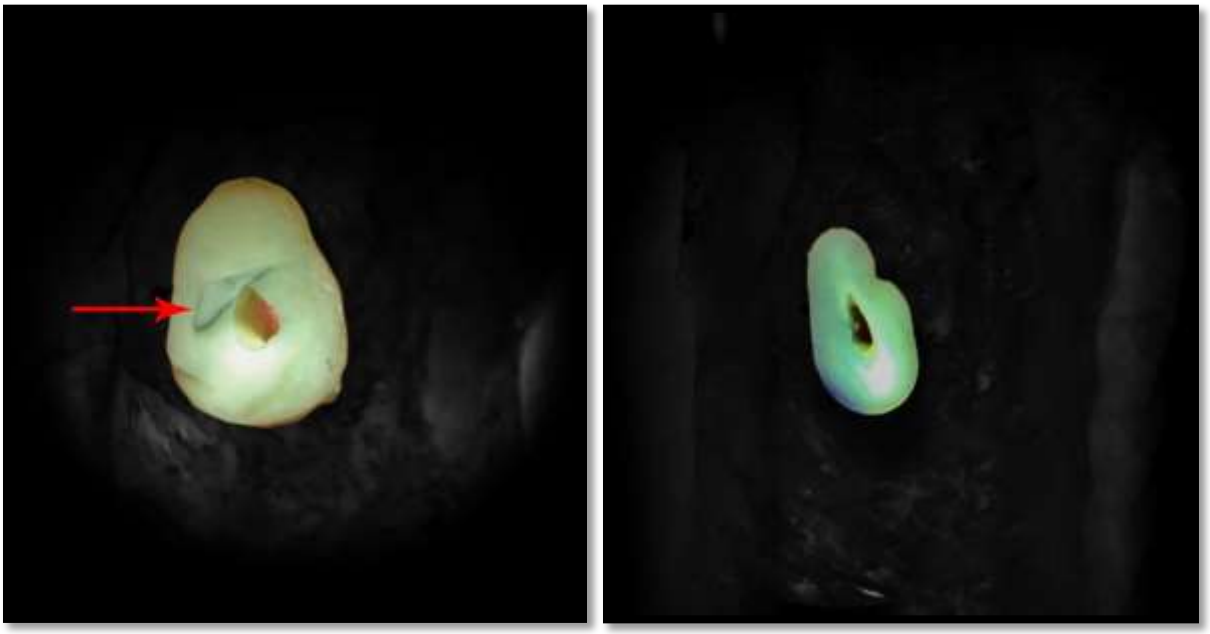
In group 1(ProTaper System),subgroup A1 were shaped with the following sequence of ProTaperNiTi system (SX,S1,S2,F1 AND F2) at a speed of 250rpm set on endodontic motor X-Smart at a constant torque 2ncm..Subgroup B1 at 300rpm ,constant torque 2ncm and subgroup C1 at speed 350rpm,constant torque 2ncm with similar sequence of protaper files as mentioned above. Irrigation of canals was done after each step with 5.25% sodium hypochlorite.
In group 2(Revo S system),subgroup A2 were first prepared with SC1(size#25file,6%taper) at a speed of 250 rpm,torque 2ncm set on endodontic motor X Smart with sweeping passive motion until 2/3rd of working length. Patency was checked with size 8k file and it was irrigated with 5.25% sodium hypochlorite. After that canal was again prepared to working length with SC2 file(size#25,4%taper) and patency was checked and irrigation was done again. Then the working length was shaped with SU file(size#25,6% taper). Similar procedure was followed with Revo-S system for subgroup B2 at speed 300rpm and subgroup C2 at speed 350rpm.In all experimental groups ,irrigation of each specimen were done with sodium hypochlorite solution between instrumentation.

Sectioning And Microscopic Examination:-

After canal preparation for either group, roots were rinsed wit 2ml of distilled water. All roots were kept moist in distilled water throughout the experimental procedure. Roots were sectioned perpendicular to long axis at 3,6,9 mm from the apex using a diamond disc under water cooling. Samples were then viewed under stereomicroscope at 40X magnification and images were captured using a digital camera. Each specimen was checked for the presence of crack

Definition Of Crack:-

''No crack'' was defined as root dentin without cracks or crazelines either at the internal surface of the root canal wall or at the external surface of the root. 'Crack'' was defined as all lines observed on the slice that either extended from the root canal lumen to the dentin or from the outer root surface into the dentin (14)



Steriomicroscopic image of specimen

A)showing crack **B)no crack**

Group 1:-(Protaper System) (18).

SPEED	NO CRACK	PRECENSE OF CRACK
250RPM (6)	3	3
300RPM(6)	1	5
350RPM(6)	0	6

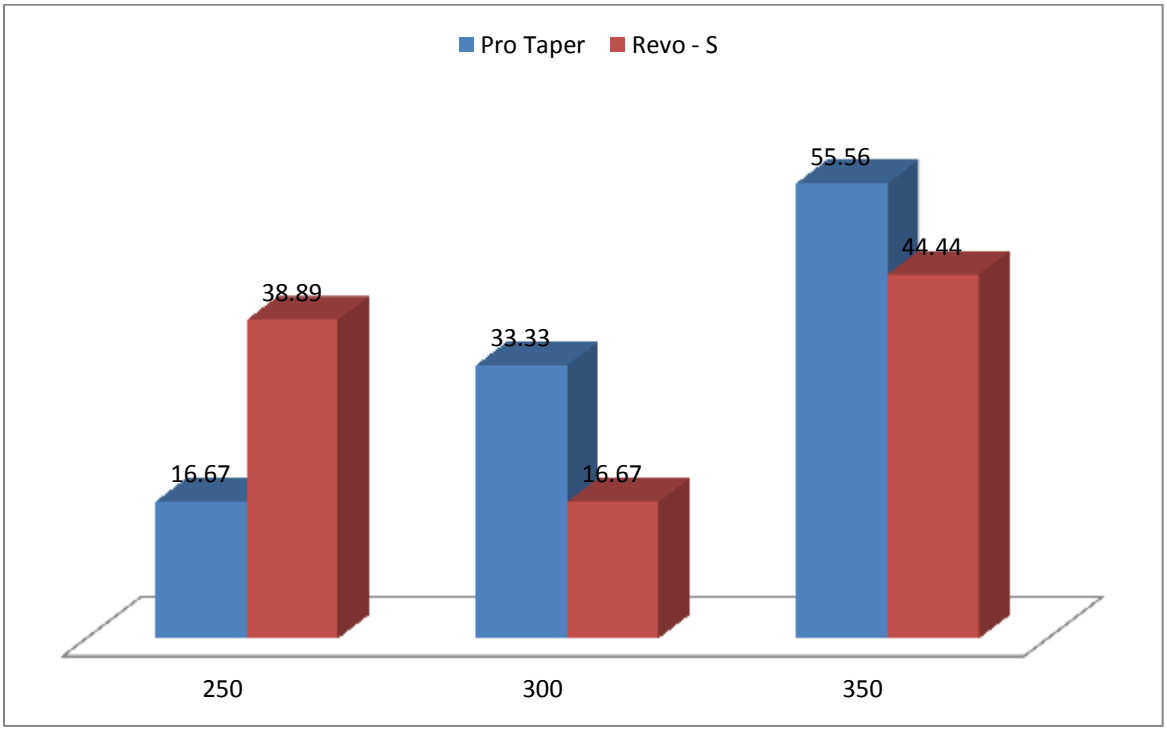
GROUP 2:-(REVO-S SYSTEM) (18)

SPEED	NO CRACK	PRECENSE OF CRACK
250RPM (6)	2	4
300RPM (6)	3	3
350RPM (6)	0	6

Statistical Analysis:-

Difference in crack formation among the groups were analyzed with testing the proportion-Z test. Results were expressed as frequency and percentage of defects in each group. P value less than 0.05 was considered statically significant. Analysis was performed on SPSS version 17.

Speed	System	Present freq	Present %	Testing the proportion - Z test p value	
250	Pro Taper	3	16.7%	.038	sig
	Revo - S	7	38.9%		
300	Pro Taper	6	33.3%	.124	NS
	Revo - S	3	16.7%		
350	Pro Taper	10	55.6%	.252	NS
	Revo - S	8	44.4%		



Results:-

Among the 18 teeth used for ProTaper system ,3 teeth showed crack at 250rpm,5 teeth showed crack at 300rpm and 6 teeth showed crack at 350rpm. Among the 18 teeth used in Revo-S system ,4 teeth showed crack at 250rpm,3 teeth showed crack at 300rpm and 6 teeth showed crack at 350 rpm (table 1)

Statistical significant difference was found between ProTaper system and Revo S system at 250 rpm ($p<0.05$) and no significant difference was found between ProTaper and Revo S at 300 and 350rpm ($p<0.05$) (table 2)

At 350rpm more percentage of micro cracks were observed for both groups when compared to speed at 250rpm and 300rpm. At 300 rpm ,both system showed less percentage of cracks in root dentin (table 3)

Discussion:-

Speed in dentistry has greater importance in all treatment procedures. According to Sturdevant,'Speed is defined as the number of revolution per minute or number of times a rotating instrument will make a full turn during a minute'.

According to Marzouk,'Speed not only refers to revolutions per minute but also to surface feet per unit time of contact that the tool has with the work to be cut'(15)

In endodontics,speed varies from 150-4,00,000rpm. Greater the speed, more the cutting efficiency.
But at higher speed,there are more disadvantages such as

1. loss of tactile sensation
2. breakage of instrument preceded by flute distortion
3. change in anatomic curvature of canal
4. loss of control (16)

To the best of our knowledge, there are no current data on the effect of different speed settings on crack formation in the literature. Therefore, we cannot compare our results with those of other studies. Dentinal crack formation is complex. It is related not only to the design of the instrument but also to its instrument's kinematics Manufacturers recommend different speeds and torque settings for different diameters of files.(17)

The result of present study showed less incidence of micro cracks with Revo S system when compared with ProTaper system at higher speed(300 and 350rpm). Manufacturers suggest that RS provides less stress on the instrument because of the asymmetrical cross-section and the extended cutting part in the coronal region, which increases instrument flexibility.(18)

NiTi instruments are used in rotational motion and rotational force is applied to root canal walls. This can create dentinal defects in root dentin.(31)

Many studies have shown that the ProTaper Universal system causes more cracks than other rotary NiTi instruments.(5,6).

In this study, less cracks were observed with ProTaper system at speed 250rpm but as speed increased ,incidence of cracks were more when compared with RevoS system at similar speed (table 3).The ProTaper universal files have active rotating movement resulting in high levels of stress concentration in root canal walls. Furthermore progressively greater taper of ProTaper files resulted in more coronal dentin removal and resulted in significantly more cracks with increase in speed .(19)

Sectioning method was used which allowed the evaluation of the effect of root canal treatment procedures on the root dentin by direct inspection of the roots.(20)

Limitations:-
Simulation of periodontal ligament was not done in the present study. Capar ID *et al*. stated that simulation of the periodontal ligament is necessary for investigating the influence of forces on formation of crack or fracture strength. Moreover, the periodontal ligament has viscoelastic property. It plays an important role in stress dissipation created by application of load to the teeth.(21)

Teeth with only straight root canals were selected without anatomic complexities which did not reproduce true clinical presentation. In some teeth microcracks might have been present pre-operatively which cannot be completely eliminated. However, further studies using other methods like optical coherence tomography or infrared thermography will eliminate the sectioning procedure and thus would be less destructive. De-Deus et al.reported that micro-CT image technology was accurate and is a non-destructive method that allows the assessment of specimens before instrumentation..(19)

Conclusion:-

Within the limitation of this in vitro study, preparing root canal with RevoS system at higher speed makes teeth less susceptible to cracks when compared with ProTaper Universal system and 300 rpm seems to be a reasonable speed to use both the rotary files for cleaning and shaping in vivo with fewer incidences of cracks.

References:-

1. Peters O. Current challenges and concepts in the preparation of root canal systems:a review. J Endod 2004;30:559–67.
2. Adorno CG, Yoshioka T, Suda H. The effect of working length and root canal preparation technique on crack development in the apical root canal wall. IntEndod J2010;43:321–7.
3. Sch€afer E, Lau R. Comparison of cutting efficiency and instrumentation of curved canals with nickel-titanium and stainless-steel instruments. J Endod 1999;25:427–30.
4. Vaudt J, Bitter K, Neumann K, Kielbassa AM. Ex vivo study on root canal instrumentation of two rotary nickel-titanium systems in comparison to stainless steel hand instruments. IntEndod J 2009;42:22–33.
5. Ashwinkumar V, Krithikadatta J, Surendran S, Velmurugan N. Effect of reciprocating file motion on microcrack formation in root canals: an SEM study. IntEndod J 2013;47:622–7.
6. Bier CA, Shemesh H, Tanomaru-Filho M, et al. The ability of different nickel-titanium rotary instruments to induce dentinal damage during canal preparation. J Endod 2009;35:236–8.
7. Liu R, Hou BX, Wesselink PR, et al. The incidence of root microcracks caused by 3 different single-file systems versus the ProTaper system. J Endod 2013;39:1054–6.
8. Yoldas O, Yilmaz S, Atakan G, et al. Dentinal microcrack formation during root canal preparations by different NiTi rotary instruments and the self-adjusting file. J Endod 2012;38:232–5.
9. Lam P, Palamara J, Messer H. Fracture strength of tooth roots following canal preparationby hand and rotary instrumentation. J Endod 2005;31:529–32.
10. Rahman H et al.In vitro evaluation of dentinal microcrack formation during rootcanal preparations by different NiTisystems.IJRD 2014;2:43-47
11. ShervinBagherie, Mohammad Mehdi Bahrani, MiladSaffaripour.Comparative study of vertical root fracture resistance of mandibular incisors and molars following canal preparation with hand K files and RevoSrotory system.
12. Sch. J. Dent. Sci. 2016; 3(5):133-136ProTaperUniversal_Brochure_enCatalogue_micromegaHakanArslan et al.Effect of ProTaperUniversal,Endoflare,Revo-S,HyFlex coronal flaring instruments and Gates Glidden Drills on crack formation.JOE 2014;40(10):1681-1683
13. Grossman's Endodntic Practice,12th editionCohen's pathways of pulp.Asim Dane et al.Effect of different torque settings on crack formation in root dentin.JOE 2016;42(2):304-306
14. OguzYoldas et al.Dentinalmicrocrack formation during root canal preparations by different NiTiRotory instruments and the self adjustingfile.JOE 2012;38(2):232-235
15. Dr.PratikMavani et al.Comparative evaluation of root microcracks by different rotory and reciprocationg endodontic file systems.IOSR-JDMS 2015;9(2):18-22
16. 20.N.Tulasi Priyaetal.'Dentinalmicrocracks after root canal preparation'.A comparative evaluation with hand,rotory and reciprocating instrumentation.JCDR 2014;8(12):70-72
17. Deepa Deepak Shoray et al.Steriomicroscopic evaluation of dentinal defects induced by new rotory system:"ProTaper NEXT".JCD 2015;18(3):210-213
18. Fuss Z, Lustig J, Tamse A. Prevalence of vertical root fractures in extracted endodontically treated teeth. IntEndod J. 1999;32(4):283-6.
19. Shemesh H, Bier CA, Wu MK, Tanomaru-Filho M, Wesselink PR. The effects of canal preparation and filling on the incidence of dentinal defects. IntEndod J. 2009;42(3):208-13.
20. Bier CA, 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. 2009;35(2):236-8
21. Barbakow F, Lutz F (1997) The Lightspeed preparation techniqueevaluated by Swiss clinicians after attending continuing education courses.*International Endodontic Journa*46–50
22. Camps JJ, Pertot WJ (1995) Torsional and stiffness properties of stainless steel and nickel–titanium endodontic files.*Journal of Endodontics***28**, 239–43.
23. Dietz DB, Di Fiore PM, Bahcall JK, Lautenschlager EP (1998) The effect of rotational speed on the breakage of nickel–titaniumrotaryfiles.*Journal of Endodontics***24**, 273 (abstract)
24. Milani AS, Froughreyhani M, Rahimi S, JafarabadiMA, Paksefat S; The effect of root canal preparation on the development of dentin cracks.IranEndod J 2012; 7(4): 177-82.
25. Pasqualini D, Scotti N, Tamagnone L, Ellena F, Berutti E. Hand-operated and rotary ProTaper instruments: a comparison of working time and number of rotations in simulated root canals.J Endod 2008;34:314–7
26. Park SY, Cheung GS, Yum J, Hur B, Park JK, Kim HC. Dynamic torsional resistance of nickel-titanium rotary instruments. J Endod 2010;36:1200–4.
27. Arun Paul et al.Steriomicroscopic evaluation of dentinal damage caused by Kfiles,Potaperuniversal,Neoniti A1,and Irace files-an in vitro study.ijar 2017;5(3):1719-1725.