VOLUME-8, ISSUE-1, JANUARY-2019 • PRINT ISSN No 2277 - 8160

Original Research Paper

Dental Science

COMPARATIVE EVALUATION OF DIFFERENT FILE SYSTEMS ON DENTINAL CRACK FORMATION IN ROOT CANALS: AN INVITRO STUDY

Dr Shahnaz

Lecturer Department Conservative Dentistry And Endodontics Govt Dental College And Hospital Srinagar

ABSTRACT

Aim: to compare conventional hand NiTi file with one rotary and one reciprocating file system for dentinal crack formation.

Materials and method: A total of 75 extracted human mandibular premolars with mature apices and straight root canals (<5°) were selected. The teeth were divided into three groups of 25 teeth each. Group 1: hand NiTi files used for instrumentation. Group 2: Protaper next rotary file system used for instrumentation. Group 3: WaveOne file system used for instrumentation. Roots were then sectioned 3, 6, and 9 mm from the apex, and the cut surface was observed under a stereomicroscope.

Results: Hand NiTi group showed no cracks formation. ProTaper Next, and WaveOne used in the study showed no statistical difference among themselves.

Conclusion: Both rotary and reciprocating files created dentinal crack formation. While as hand files presented with satisfactory results with no dentinal microcracks

KEYWORDS : Dentinal microcracks, nickel-titanium files, reciprocation,

Introduction:

Canal shaping procedures and rotary instrumentation with NiTi instruments can induce crack formation.[1] Crack is defined as a defect with complete crack lines extending from inner root canal space up to the outer surface of the root.[2,3] These Dentinal cracks or root fracture occur when the tensile stress in the root canal wall exceeds the tensile stress of dentin.[1,4] Endodontic Rotary NiTi files having large tapers can cause increased friction and stresses on the canal wall and cause dentinal cracks in root dentin.[4] In the last decade, there has been increasing number of proprietary systems introduced commercially.[4] Increased flexibility and shortened working time are the major advantages of NiTi files.[5,6]]. From 2007, manufacturers began to focus on utilizing heating and cooling methods to reduce cyclic fatigue and improve safety when rotary NiTi instruments work in more curved canals,[7] i.e. WaveOne. Another advancement in canal preparation procedures that utilizes reciprocation which may be repetitive up and down or back and forth motion was of the fourth generation.[8] The fifth generation of files has been designed such that the center of mass and/or the center of rotation are offset,[8] Commercial examples of file brands that offer variations of this technology are ProTaper Next. ProTaper Next (Dentsply Maillefer) is a set of rotary instruments that are designed with variable tapers and an off-centered rectangular cross-section which is made from M-wire technology.[9] therefore this study was designed to compare effect of these file systems on dentinal crack formation.

Materials and method:

A total of 75 extracted human mandibular premolars with mature apices and straight root canals (<5°) were selected and kept in distilled water. The root surfaces were examined under stereomicroscope to exclude external defects and cracks. Then, the teeth were decoronated to obtain a standardized root length of 16 mm. A single layer of aluminum foil was used to cover the roots of the teeth, and each root was embedded into acrylic resin set in an acrylic tube. Root was removed, from tube, and the aluminum foil was removed from the root. A light-body silicon-based material was used to replace space created by aluminum foil and simulate periodontal ligament, and the root was immediately inserted into impression material. Seventy-five teeth were divided into three groups of 25 teeth each. Canal length was measured and glide path preparation was done by 15k-type files. Apical preparation was completed with size 25 instrument of each system. 1% sodium hypochlorite solution was used as an irrigant during instrumentation.

Group 1:

NiTi hand K-files were used to enlarge the root canals up to size 25K using the balanced force technique. Files were inserted by a quarter-turn clockwise rotation of 90° with no apical pressure and cutting was accomplished by counter-clockwise rotation of 120° applying sufficient apical pressure. Then, working length was incrementally reduced by 1 mm beginning from #30 to #60 K-file.

Group Following the sequence of ProTaper Next (Dentsply Maillefer, Ballaigues, Switzerland) files were used to prepare the canals as recommended by the manufacturer. The shaping file XA was used for coronal enlargement up to two-third of the working length, then X1 and X2 files were used at 300 rpm and 2Ncm torque till working length. Here, X2 correspond to apical size 25 and 6% apical taper.

Group 3

Reciprocating WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) size 0.08/25 file was used in a reciprocating, slow in and out pecking motion with a 6:1 contra-angle handpiece powered by a torque-limited electric motor (WaveOne™ motor, Dentsply Maillefer, Ballaigues, Switzerland) at 350 rpm as recommended by manufacturer.

Sectioning and microscopic observations

All roots were cut horizontally at three levels (3, 6, and 9 mm) from the apex with diamond disc under constant water cooling. Sections were then viewed under stereomicroscope (Olympus, Tokyo, Japan) at 20X magnification. The root cracks were divided into two categories [Table 1].

Statistical analysis

The results were expressed as the number and percentage of cracks in each group. The data was analyzed with a Chi-square test.

Table 1: Categories used to evaluate the crack type

Type of crack	Definition
No defect	Root dentin devoid of any craze lines or cracks where both the external surface of the root and the internal root canal wall will not have any evident defects
Defect	A craze line, a line extending from the outer surface into the dentin but will not reach the canal lumen A partial crack, a line extending from the canal walls into the dentin without reaching the outer surface. A fracture, a line extending from the root canal space all the way to the outer surface of the root

Table 2: number of dentinal defects at various levels of roots			
Root level	**Group 1 (NiTi hand files)**	**Group 2 (protaper next)**	**Group 3 (wave one)**
3mm	0(0%)	4(15%)	2(7.5%)
6mm	0(0%)	4(15%)	2(7.5%)
9mm	0(0%)	8(30%)	6(7.5%)
total	0(0%)	16(60%)	10(40%)

RESULTS

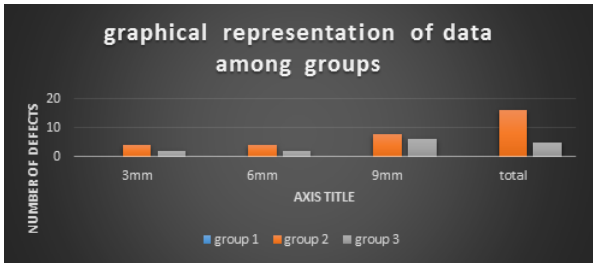
No crack formation was observed in NiTi hand instrument group. Cracks were found in roots instrumented with ProTaper Next, and WaveOne [Table 2]. Among the specimens depicting cracks, ProTaper files showed the highest number of cracks at all three levels and WaveOne showed least number of cracks at all three levels . Among the cracked specimens, the results representing the number of cracks in roots instrumented with ProTaper Next, and WaveOne were statistically insignificant ($P = 0.99$) as compared to hand files.

DISCUSSION

Endodontic root canal preparation is one of the principal steps in achieving endodontic success. Inadvertent instrumentation during canal preparation and retreatment cases may end up with the complications such as perforations, canal transportation, ledge, zip formation, and separation of Instruments. [10, 11, 12] During preparation, the contact between the instrument and canal walls creates momentary stress concentrations in dentin which may lead to dentinal defects wherein vertical root fracture can initiate. Microcracks formation may be related to instrument features such as tip design, cross-sectional geometry, taper, pitch design, and flute form.[10] In this study, all teeth were inspected for pre-existing cracks or fracture. However, ruling out cracks before the start of the experiment is difficult because some of these cracks could be internal and may not be visible externally. In the current study, hand NiTi showed no microcracks formations. The findings were similar to Bier *et al.*[13] findings. Hand instrumentation did not cause damage to the root dentin due to its less aggressive movements in the canal compared with engine operated files. According to the findings of this study, WaveOne file created lesser cracks as compared to protaper next rotary files system. Reciprocation is based on the fundamental of balanced force technique by Roane *et al.*[14] which probably minimizes torsional and flexural stresses. Moreover, WaveOne instrument is manufactured with M-wire, which is a more flexible variant of the NiTi alloy. Kansal *et al.*[15] conducted a similar study and found that when ProTaper and WaveOne files were used in reciprocating motion, it induced lesser dentinal damage as compared to ProTaper file used in rotary motion. Higher incidence of crack formation was seen with ProTaper next file system. The design of file may affect shaping forces on root dentin; these forces may cause root fracture.[16,17] ProTaper Next has a rectangular cross-section design, increased and decreased tapering over entire length. The standardization of speed and torque settings for different file systems could be a limitation of the present study. Furthermore, it was difficult to standardize the downward force used during each instrumentation. Also, teeth with straight root canals without anatomical complexities were mounted on resin blocks, which might not always reproduce a true clinical presentation. A drawback of using resin blocks is heat generation and softening of the resin material[18] One of the limitations of this study was application of elastomeric material to simulate the periodontal ligament.

CONCLUSION

Within the limitations of this study, we can conclude that different NiTi instruments tend to produce varying degrees of dentinal damage during root canal preparation. Various factors cause dentinal cracks, but the flexibility of file due to heat treatment, kinematics of the file and the basic architecture of the file are the most significant ones. Hand instrumentation and file represented satisfactory results with no microcracks defects.



REFERENCES:

1. 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;35:236-8.
2. Bürklein S, Tsotsis P, Schäfer E. Incidence of dentinal defects after root canal preparation: Reciprocating versus rotary instrumentation. J Endod 2013;39:501-4.
3. Li SH, Lu Y, Song D, Zhou X, Zheng QH, Gao Y, et al. Occurrence of dentinal microcracks in severely curved root canals with ProTaper universal, WaveOne, and ProTaper next file systems. J Endod 2015;41:1875-9.
4. Dane A, Capar ID, Arslan H, Akçay M, Uysal B. Effect of different torque settings on crack formation in root dentin. J Endod 2016;42:304-6.
5. Ferraz CC, Gomes NV, Gomes BP, Zaia AA, Teixeira FB, Souza-Filho FJ, et al. Apical extrusion of debris and irrigants using two hand and three engine-driven instrumentation techniques. Int Endod J 2001;34:354-8.
6. Walia HM, Brantley WA, Gerstein H. An initial investigation of the bending and torsional properties of nitinol root canal files. J Endod 1988;14:346-51.
7. Gutmann JL, Gao Y. Alteration in the inherent metallic and surface properties of nickel-titanium root canal instruments to enhance performance, durability and safety: A focused review. Int Endod J 2012;45:113-28.
8. Ruddle CJ, Machtou P, West JD. The shaping movement: Fifth-generation technology. Dent Today 2013;32:94, 96-9.
9. Ruddle CJ. The proTaper endodontic system: Geometries, features, and guidelines for use. Dent Today 2001;20:60-7.
10. 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;38:232-5.
11. Jeon HJ, Paranjpe A, Ha JH, Kim E, Lee W, Kim HC, et al. Apical enlargement according to different pecking times at working length using reciprocating files. J Endod 2014;40:281-4.
12. Rhodes SC, Hülsmann M, McNeal SF, Beck P, Eleazer PD. Comparison of root canal preparation using reciprocating Safe siders stainless steel and Vortex nickel-titanium Instruments. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;111:659-67.
13. 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;35:236-8.
14. Roane JB, Sabala CL, Duncanson MG Jr. The "balanced force" concept for instrumentation of curved canals. J Endod 1985;11:203-11.
15. Kansal R, Rajput A, Talwar S, Roongta R, Verma M. Assessment of dentinal damage during canal preparation using reciprocating and rotary files. J Endod 2014;40:1443-6.
16. Lam PP, Palamara JE, Messer HH. Fracture strength of roots following canal preparation by hand and rotary instrumentation. J Endod 2014;37:997-1001.
17. Kim HC, Lee MH, Yum J, Versluis A, Lee CJ, Kim BM, et al. Potential relationship between design of nickel-titanium rotary instruments and vertical root fracture. J Endod 2010;36:1195-9.
18. Abu Haimed AS, Abuhaimed TS, Dummer PE, Bryant ST. The root canal shaping ability of WaveOne and Reciproc versus ProTaper Universal and Mtwo rotary NiTi systems. Saudi Endod J 2017;7:8-15.