



Comparison of Dentinal Microcracks Formation Using Two Different Rotary Systems and Hand Instruments

Valbona Disha^{1*}

Nilena Eriksen¹

Erda Qorri¹

Olta Cakaj¹

Enxhi Subashi¹

¹Department of Paediatric Dentistry, Albanian University, Albania

*Email: n.eriksen@albanianuniversity.edu.al

Abstract

Introduction: The endodontic success is attributed to a variety of factors, but one of the most important is canal preparation. Among causes of endodontic failures is vertical root fracture, which may result from gradual propagation of initial dentinal defects. Radicular canal preparation with hand instruments or with rotary systems seems to play an important role in initiation of dentin defects which later can propagate to vertical root fractures. **Aim:** The aim of this study was to compare the incidence of dentinal microcracks after instrumentation with Neolix, SCpro and hand instrumentation. **Materials and method:** 40 freshly extracted human maxillar centrals were collected and stored in formalin solution for two weeks. 40 samples collected were divided into four groups with ten teeth in each. Group 1 – unprepared root canal shaping group (control group), group 2 – hand instrumentation, group 3 – prepared by Neolix and group 4 – prepared by SCpro (SOCO). All teeth were cut by diamond disc in cervical one third of root and inspected under XJM300 KOZO microscope. **Results:** The highest number of microcracks was found in root canals prepared with SCpro and only one was found in a root canal prepared with Neolix. No cracks were observed in the control group and hand instrumentation group. **Conclusion:** Rotary instruments caused dentin defects compared to hand instrumentation which didn't cause any defects in radicular dentin. SCpro rotary system caused more dentinal damage compared to

Neolix. Considering the extent of dentinal microcracks, Neolix rotary system can be considered a safe alternative to hand instrumentation.

Keywords: Dentin microcracks, rotatory system, hand instrumentation, defects, root fracture

Introduction

Root canal preparation is an important step in the successful treatment of endodontically involved teeth. According to the American Association of Endodontics, this procedure assures the debridement and disinfection of the root canal providing space for the placement of obturation materials. The main goals of this procedure are to preserve the natural dentition for the lifetime of the patient and to prevent apical periodontitis [1]. It is very important that this procedure preserves the natural shape of the root canals in order to achieve the goals mentioned above. The sufficient amount as well as the quality of the remaining radicular dentin is crucial for the long-lasting life of the affected tooth.

Root canal instrumentation involves the use of files which can be manipulated manually or by rotary systems. Each of the techniques has their strengths and weaknesses. The latest uses nickel-titanium (NiTi) files, which possess two important properties like super elasticity and high resistance to cyclic fatigue, which seem to have decreased common canal instrumentation problems like formation of blocks, ledges, or perforation [2]. Although, use of rotary systems reduces the time of canal preparation respecting the original shape of the canals [3], it seems that rotary instrument can cause damages in the dentin walls. High number of rotations of the instruments inside the root canal may cause more friction between the files and the dentin walls which can lead to craze lines, microcracks or vertical root fractures.

The aim of this study was to compare dentin microcracks formation between hand instrumentation and rotary instrumentation with two different types of rotary systems, Neolix and SCpro (SOCO).

Methodology

This *in vitro* experimental study was conducted on 40 freshly extracted maxillary incisors. The teeth had been extracted due to periodontal reasons. The teeth were stored in formalin before experiment. For this study, the teeth were randomly divided into four groups, control group, hand instrumentation, Neolix and SCpro (SOCO). No preparation was made in the control group. Root canal preparation in the last two groups was performed according to the manufacturers' instructions (for Neolix 500 rpm and 1.5 Ncm and for SCpro 350 rpm and 1.5 Ncm). The working length was set 1 mm short of the apical foramen and enlargement was performed at the working length with K files #15. The preparation of all the teeth was performed by the same operator, to prevent discordances in technique of instrumentation or dexterity. After enlargement up to file #25 teeth were stored in blue methyl for a week.

After one week, sections of all specimens were obtained at coronal 1/3 region of root using a diamond disk. The sections were evaluated under XJM300 KOZO microscope and images were captured with digital camera (S/N: T800045 8.0MP). Images were

then analyzed and compared visually for eventual cracks or craze lines present in dentin, on the interior and exterior surface of the root. Data were elaborated in Excel and presented in percentages of teeth with dentinal defects for each of the groups.

Data Collection

No defects were noted in the first group (control group) and second group (hand instrumentation) referred to the images (Figure 1.a, 1.b). Two other groups (Neolix and SCpro) showed cracks in dentin thickness (Figure 1.c, 1.d). The highest number of cracks was found in root canals prepared with SCpro (Figure 1.d) and only one defect was found in a root canal prepared with Neolix (Figure 1.c).

a. No instrumentation b. Hand instrumentation c. Neolix d. SCpro

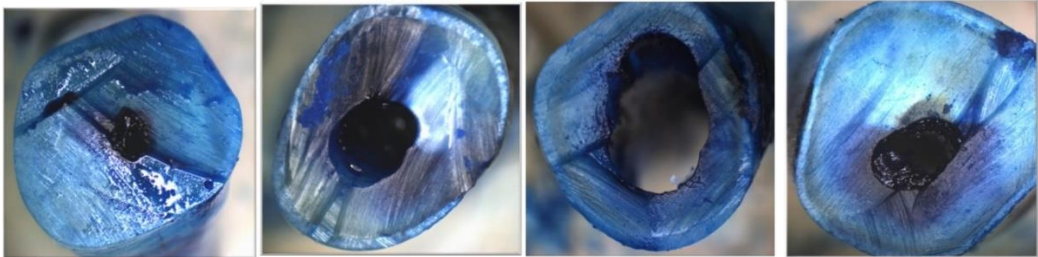
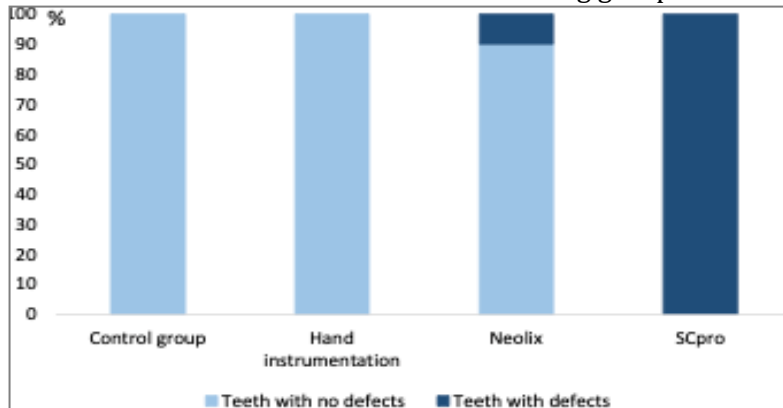


Figure 1. Photos of samples of each group

Instrumentation	Nr. of teeth	Teeth with dentin cracks (coronar 1/3)	
		Nr	%
No instrumentation	10	0	0
Hand instrumentation	10	0	0
Neolix	10	1	10
SCpro	10	10	100

Table 1. Distribution of dentinal cracks among groups



Graphic 1. Percentage of teeth with/no dentinal defects

Average of dentinal cracks for group prepared with SCpro was 3 cracks for root and one for Neolix. All dentinal cracks were partial.

Discussion

The appearance of dentinal micro cracks at the level of radicular canals of teeth with endodontic treatment is a frequent finding evidenced by numerous *in vitro* studies. The force exerted during mechanical preparation, especially with rotary instruments, speed of rotations, typology of movements of the instruments, etc. are some of the factors that are believed to induce their appearance. In this study we evaluated and compared the aspect of radicular dentin walls in one third of coronal region between no preparation group (control group) and three groups of extracted teeth endodontically instrumented by hand and two different rotary instrument systems (Neolix and SCpro SOCO).

In our study, all teeth in control group showed no evidence of any dentinal defects. Also, hand instrumented teeth did not present any damage in dentinal root wall, being in accordance with other similar studies conducted previously to compare hand instrumentation with other types of rotary instruments [4,5,6,7].

Presence of microcracks in dentin walls is a common conclusion of numerous *in vitro* studies regarding Ni-Ti rotary systems [4,6,8,9], which can also be confirmed in the present study. The two experimental groups instrumented with rotary instrument systems showed dentinal defects observed as partial cracks starting from the internal surface of radicular dentin that didn't end up at the outer surface. Preparation of root canals with Neolix and ScPro Systems both created lines in the dentin thickness of the coronal one third of the root.

In our study teeth were sectioned only at the coronal one third. It has been shown by other studies [6,8,13] that most of the cracks occur in the coronal region of the root and we wanted to observe their occurrence in an area so vulnerable to instrumentation. This observation can be explained, as Versluis *et al* [10] indicate in their study, by the fact that stresses distributed within canals increased three times more in coronal one-half of the canal, compared to apical region. This could be the result of increased taper of the instrument toward the coronal dentinal walls [8].

As mentioned above, we evaluated the presence of dentin defects in the coronal region, and teeth were analyzed under the stereomicroscope only after sectioning. This method is considered a destructive technique according to Valle *et al.*, which doesn't take into consideration the potential injury caused by interaction of different sources of stress on root canal dentin, among others the mechanical preparation itself, the sectioning methodology or inherent dehydration caused by the difficulty of maintaining an adequate condition during procedure execution [11]. Stringheta *et al.*, also consider that this cross-sectioning method limits the assessment to only a few levels of the root canal and produces irreversible changes to the specimen [12]. However, in our study, all groups (unprepared group, hand instrumented group, Neolix group and ScPro group) were assessed after sectioning and the presence of

dentinal defects was observed only in the instrumented group with rotary systems. We can assume that this is a consequence of instrumentation factor.

Although both experimental groups in this study showed presence of dentin cracks, the difference between them was important (10% presence of defects for Neolix system and 100% presence of defects for ScPro SOCO), Graphic 1. From our literature research, studies about Neolix systems are not numerous, whereas for ScPro we couldn't identify any previous study. When compared to other rotary systems the results about Neolix are not consistent. Several studies [8,13,14] have shown that Neolix system creates more damage in dentin walls resulting in cracks ranging from 40%, 43%, to 70% respectively, compared to only 10% observed in our study, whereas other studies refer to Neolix systems as a suitable alternative to other rotary systems since use of this single-file system saves time and cost and minimizes trauma to dentinal walls [15,16]. On the other hand, when it comes to comparing shaping characteristics in curved root canals, canal transportation, separation rate, debris extrusion, time of preparation, effect on Peri Cervical Dentin (PCD), Neolix seems to perform better than other rotary systems: Protaper – Forghani *et al.*, [3]; One Shape™- Kuzekani *et al.* [17]; Reciproc, - Mohammadi *et al.*, Singbal *et al.* [19,20]; Reciproc, Oneshape, WaveOne – Zinge *et al.* [21], or the same (EdgeGlidePath, One-G – Shojaeian *et al.*[18]. The latest characteristics derive from the fact that Neolix files (according to the manufacturer) have a rough surface and abrasive properties which can lead to faster canal preparation [3] as well as to the fact that Neolix files do not have the usual metallic memory and have tendency to rapidly return to straight position due to the use of a newly developed machining process and an appropriate heat treatment which causes the special progressive flexibility of the files [21].

Conclusion

With all the limitations of this *in vitro* study, we conclude that rotary instruments show more dentin defects than hand instrumentation. Preparation with SCpro SOCO created more microcracks in internal coronal third of dentin walls compared to Neolix. Also time of preparation with Neolix System was shorter and the procedure of root preparation was comfortable for the operator.

References

- [1] Guide to Clinical Endodontics, Sixth Edition, American Association of Endodontists, www.aae.org
- [2] Cohen, S., & Hargreaves, K. M. (2006). *Pathways of the pulp*. Mosby.
- [3] Forghani M, Hezarjaribi M, Teimouri H. Comparison of the shaping characteristics of Neolix and Protaper Universal systems in preparation of severely-curved simulated canals. *J Clin Exp Dent*. 2017;9(4):e556-9.
- [4] 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 Feb;35(2):236-8. doi: 10.1016/j.joen.2008.10.021. PMID: 19166781.

- [5] Oguz Yoldas, Sehnaz Yilmaz, Gokhan Atakan, Cihan Kuden, Zeynep Kasan - Dentinal microcrack formation during root canal preparations by different NiTi rotary instruments and the self-adjusting file. *J Endod.* 2012 Feb;38(2):232-5. doi: 10.1016/j.joen.2011.10.011.
- [6] Priya NT, Chandrasekhar V, Anita s, Tummala M, Raj, Badami V, Kumar P, E.Soujanya. "Dentinal Microcracks After Root Canal Preparation" A Comparative Evaluation with Hand, Rotary and Reciprocating Instrumentation. *J Clin of Diagn Res.*2014; 8(12):ZC70-ZC72.
- [7] Garg S, Mahajan P, Thaman D, Monga P. Comparison of dentinal damage induced by different nickel-titanium rotary instruments during canal preparation: An in vitro study. *J Conserv Dent.* 2015;18(4):302-305. doi:10.4103/0972-0707.159730
- [8] Harandi A, Mirzaeerad S, Mehrabani M, Mahmoudi E, Bijani A. Incidence of Dentinal Crack after Root Canal Preparation by ProTaper Universal, Neolix and SafeSider Systems. *Iran Endod J.* 2017 Fall;12(4):432-438. doi:10.22037/iej.v12i4.17597. PMID: 29225637; PMCID: PMC5722122.
- [9] Kesim B, Sagsen B, Aslan T. Evaluation of dentinal defects during root canal preparation using thermomechanically processed nickel-titanium files. *Eur J Dent.* 2017;11(2):157-161. doi:10.4103/ejd.ejd_254_16
- [10] Versluis, A., H. H. Messer, and M. R. Pintado. "Changes in Compaction Stress Distributions in Roots Resulting from Canal Preparation." *International Endodontic Journal* 39.12 (2006): 931–939. doi:10.1111/j.1365-2591.2006.01164.x
- [11] Valle AD, Dotto L, Morgental RD, Pereira-Cenci T, Pereira GKDR, Sarkis-Onofre R. "Influence of Root Canal Preparation on Formation of Dentinal Microcracks: A Systematic Review." *Braz Dent J.* 2020 Jun;31(3):201-220. doi: 10.1590/0103-6440202002652. PMID: 32667513.
- [12] Stringheta CP, Pelegrine RA, Kato AS, Freire LG, Iglecias EF, Gavini G, Bueno CEDS. "Micro-computed Tomography versus the Cross-sectioning Method to Evaluate Dentin Defects Induced by Different Mechanized Instrumentation Techniques". *J Endod.* 2017 Dec;43(12):2102-2107. doi: 10.1016/j.joen.2017.07.015. PMID: 29033087.
- [13] Chandwani N, Ranka A, Jadhav GR, Jagyasi D, Bopche P, Golchha A. "Effect of various single file systems on microcrack formation in root canals: Scanning electron microscope study". *Dent Res J (Isfahan).* 2021 Jul 19;18:52. PMID:34497687;
- [14] Pandey SH, Patni PM, Jain P, Raghuwanshi S, Sanwatsarkar G, Chaturvedi A. "Light emitting diode assessment of dentinal microcracks after root canal preparation with 4 different heat-treated file systems. *Minerva Dent Oral Sci.* 2021 Dec;70(6):257-262. doi: 10.23736/S2724-6329.21.04523-X. PMID: 34264044;
- [15] Khoshbin E, Shokri A, Donyavi Z, Shahriari S, Salehimehr G, Farhadian M, Kavandi Z. "Comparison of the root canal debridement ability of two single file systems with a conventional multiple rotary system in long oval-shaped root canals: In

- vitro study.” *J Clin Exp Dent*. 2017 Aug 1;9(8):e939-e944. doi: 10.4317/jced.52977. PMID: 28936281;
- [16] Khoshbin E, Donyavi Z, Abbasi Atibeh E, Roshanaei G, Amani F. “The Effect of Canal Preparation with Four Different Rotary Systems on Formation of Dentinal Cracks: An In Vitro Evaluation.” *Iran Endod J*. 2018 Spring;13(2):163-168. doi: 10.22037/iej.v13i2.16416. PMID: 29707009.
- [17] Kuzekanani M, Sadeghi F, Hatami N, Rad M, Darijani M, Walsh LJ. “Comparison of Canal Transportation, Separation Rate, and Preparation Time between One Shape and Neolix (Neolix): An In Vitro CBCT Study. *Int J Dent*. 2021 Sep 7;2021:6457071. doi: 10.1155/2021/6457071. PMID: 34539788;
- [18] Shojaeian S, Mortezapour N, Soltaninejad F, Zargar N, Zandi B, Shantiaee Y, Bidaki A. Comparison of Canal Transportation and Centering Ability of One-G, EdgeGlidePath, and Neolix: A Micro Computed Tomography Study of Curved Root Canals. *Int J Dent*. 2021 Nov 9;2021:4898684. doi: 10.1155/2021/4898684. PMID:34795762;
- [19] Mohammadi D, Mehran M, Frankenberger R, BabeveyNejad N, Banakar M, Haghgoo R. “Comparison of apical debris extrusion during root canal preparation in primary molars using different file systems: an in vitro study.” *Aust Endod J*. 2021 Nov 8. doi:10.1111/aej.12582. Epub ahead of print. PMID: 34751479.
- [20] Singbal K, Jain D, Raja K, Hoe TM. “Comparative evaluation of apically extruded debris during root canal instrumentation using two Ni-Ti single file rotary systems: An in vitro study.” *J Conserv Dent*. 2017 Mar-Apr;20(2):64-67. doi: 10.4103/0972-0707.212236. PMID: 28855748;
- [21] Zinge PR, Patil J. “Comparative evaluation of effect of rotary and reciprocating single-file systems on pericervical dentin: A cone-beam computed tomography study.” *J Conserv Dent*. 2017 Nov-Dec;20(6):424-428. doi: 10.4103/JCD.JCD_201_17. PMID: 29430095;