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The efficiency of canal cleaning with reciprocating movements instruments – SEM study

Ефикасност чишћења канала инструментима са реципрочним покретима – СЕМ студија

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SUMMARY

Introduction/Aim The application of NiTi instruments in cleaning and shaping of the root canal system is a standard and a precondition for the success of endodontic treatment. The aim of this study was to use SEM analysis in order to examine the efficiency of cleaning the apical third of the root canal system using two different NiTi systems with reciprocating movements.

Methods The study included 20 single-rooted teeth (premolars) divided into two groups. In group 1, the canal preparation was realized with a single file UNICONE with reciprocating movements (MEDIN, Czech Republic), and in group 2, with RECIPROC BLUE instrument with reciprocating movements (UDW, Germany). The same quantities of a 2% NaOCl solution and a 17% EDTA solution were used as irrigation solutions. The samples prepared for SEM analysis of the smear layer in the apical third were evolved on a scale of 1–5 and at a magnification of 1000×.

Results SEM analysis pointed to mostly clean canal walls in the apical segment in both tested groups. Slightly cleaner walls were observed after the application of the UNICONE file (78%) compared to the samples of the second group where the instrumentation was realized by the RECIPROC BLUE file (76%), but without statistically significant differences.

Conclusion Single-file reciprocating systems do not remove the smear layer completely, but provide efficient cleaning of the apical region of the canal.

Keywords: cleaning, smear layer, reciprocating movements, SEM, NiTi instruments

САЖЕТАК

Увод/Циљ Примена *NiTi* инстурмената у чишћењу и обликовању канала је стандард и предуслов за успех ендодонтског третмана. Циљ овог рада је био да се СЕМ анализом провери ефикасност чишћења апикалне трећине канала применом два различита *NiTi* система са реципрочним покретима.

Методе У истраживање је укључено 20 једнокорених зуба (премолара) подељених у две групе. Препарација канала у првој групи је реализована једном турпијом са реципрочним покретима *UNICONE* (*MEDIN*, Чешка), а у другој инструментом са реципрочним покретима *RECIPROC BLUE* (*UDW*, Немачка). Као раствори за иригацију коришћене су исте количине 2% раствора *NaOCl* и 17% раствор *EDTA*. Узорци припремљени за СЕМ анализу размазног слоја у апикалној трећини су еволуирани према скали од 1–5 и на увеличању од 1000×.

Резултати СЕМ анализа је указала на углавном чисте зидове канала у апексном сегменту у обе тестиране групе. Нешто чистији зидови уочени су после примене *UNICON* турпије (78%) у односу на узорке друге групе где је инструментација реализована *RECIPROC BLUE* турпијом (76%), али без статистички значајних разлика.

Закључак Реципрочни системи са једном турпијом не уклањају потпуно размазни слој али обезбеђују ефикасно чишћење апикалне регије канала.

Кључне речи: чишћење, размазни слој, реципрочни покрети, СЕМ, *NiTi* инструменти

INTRODUCTION

The preparation of the root canal system is one of the most important stages in endodontic therapy, and the application of NiTi instruments in the cleaning and shaping of the canal is a standard and a prerequisite for the success of endodontic treatment [1]. Adequate root canal preparation increases the efficiency of irrigants and medicines and ensures satisfactory geometry and canal dimensions for better quality of the obturation [2].

Problems related to frequent fractures and deformations of NiTi rotating instruments during the preparation influenced the introduction of new systems and concepts of preparation that are based on changing the dynamics of movement and reducing the number of instruments necessary for adequate cleaning and shaping of the canal [2, 3, 4].

A system of preparation based on the application of NiTi instruments with reciprocating movements, and the fact that these systems are most commonly presented with only one instrument, showed new possibilities in the instrumentation [2, 5, 6, 7]. The reciprocating movements of the instrument (based on the technique of balanced forces) imply alternating rotation of the instrument in the direction of counterclockwise movement and much shorter movement in the clockwise direction, which significantly reduces torsional stress and cyclical fatigue, and thus the possibility of breakage of the instrument during preparation [2, 8, 9].

The research indicates that reciprocating movements do not diminish the cutting efficiency of the files and that the quality of the preparation depends primarily on the design of the working part of the instrument, the cross-section, the material from which it was made and the special treatment of the alloy and the surface of the working part of the file [2, 3, 5, 10]. Cutting efficiency can be reduced only due to prolonged clinical use [11]. The studies also confirmed that the files with reciprocating movements are able to design both straight and curved canals equally well, thanks to the cross-section of the file, the M-WIRE alloy and the reciprocating kinematics [5, 12].

The concept of preparation by a single instrument significantly reduces preparation time, but also allows endodontists to devote more time to irrigation techniques in order to increase the efficiency of cleaning and disinfection of a complex canal system [3, 5, 13]. Endodontic practice confirms that the fundamental cleaning of the canal system is difficult to achieve and that the particular problem is the apical segment of the canal [2, 3, 5].

The data on the effects of files with reciprocating movements on the quality of cleaning and removing the smear layer from the canal walls are relatively scarce and mostly indicate similar findings with NiTi full rotation systems [10, 14, 15, 16].

The aim of this study was to use SEM analysis in order to examine the efficiency of cleaning the apical third of the root canal system using two different NiTi systems with reciprocating movements.

The null hypothesis of this study is that there will be no significant differences in the amount of the smear layer in different reciprocating systems with a single file.

METHODS

The study included 20 single-rooted teeth (premolars) extracted due to periodontal problems. The study was realized with the permission of the Ethics Committee of the School of Dental Medicine in Belgrade, 36/6, 10 January 2013.

With all the teeth, after the formation of the access cavity on the occlusal surface of the teeth, a certain working length is determined (1 mm shorter than the length at which the top of the instrument appears at the apex). At the top of each root, a pink wax bead is placed in order for the preparation to be carried out under the conditions that are most closely related to the clinical situation. The teeth were then randomly divided into two groups (10 teeth).

In the first group, the canal preparation was realized with a single instrument UNICONE with reciprocating movements (MEDIN, Czech Republic), sizes 25/06. After examining the passage through the hand instrument (ISO 15), the canal was filled with 0.5 ml of a 2% NaOCl solution (CHLORAXID 2%, CERCAMED, POLAND) and the instrument was placed to the working length (3–5 times) with gentle pulling movements. After extracting the instrument, the remaining amount of NaOCl solution (0.5 ml) was applied into the canal. Then, a 17% EDTA solution (CALCINASE, EDTA solution, Lege Artis, Pharma GmbH)

was placed into the canal and with the same movements (3-5 times) was further placed to the working length (1 ml). The final rinsing was done with an additional 2 ml of a 2% NaOCl solution. The preparation was carried out by ENDO A CLASS endomotor (MEDIN, Czech Republic).

In the second group, the canal preparation was also realized with a single instrument RECIPROC BLUE with reciprocating movements (VDW, Gmbh, Germany), sizes 25/08, in the same way as in the first group. The preparation in this group was realized by the VDW SILVER endomotor (VDW, Gmbh, Germany).

SEM ANALYSIS

After completion of the instrumentation, the dental crowns were cut in the cementoenamel junction, so that the remaining root length was 10 mm. The roots were then separated into half (20 in each group) by a diamond disc and a chisel.

Only the apical third of the root (region of 3 mm from the boundary of the preparation) was selected for analysis, so that 5 standard microphotographs (total of 200 images) were made for each sample on magnification of 1000x (JEOL; JSM, 6460LV, Japan).

The presence of the smear layer in the apical third of the canal was evaluated according to the criteria of Hülsmann et al. [16].

Score 1 – no smear layer, dentine tubules are open

Score 2 – a little smear layer, several tubules are open

Score 3 – a homogeneous smear layer covers the wall, a few tubules are open

Score 4 – the entire wall of the canal is covered with a smear layer, there are no open tubules

Score 5 – a non-homogenous smear layer covers the entire wall of the canal

The analysis and the scoring of the saved microphotographs were done by two independent researchers. In the event of disagreement, the discussion lasted until consensus was reached.

The clean wall of the canal included scores 1 and 2 and the wall with the present smear layer included scores 3, 4 and 5.

The results were processed in the SPSS 20 program (IBM, Chicago), and the descriptive statistics method and the Hi square test were used in the statistical analysis.

RESULTS

The obtained results are shown in Tables 1, 2 and 3 and in Figures 1 and 2.

SEM analysis of the canal walls showed that no reciprocating motion system provided complete cleaning in the apical third. The average values of the smear layer were similar and slightly less in the first group where the instrumentation was realized with the UNICONE instrument (1.88), compared to the second group where the RECIPROC BLUE instrument (2.04) was used (Table 1).

The obtained results indicated somewhat cleaner walls of the apical part of the canal (scores 1 and 2) in the samples of the first group and after the application of the UNICONE instrument (78%), compared to the samples of the second group and the instrumentation with the RECIPROC BLUE file (76%) (Tables 2 and 3).

The presence of the smear layer in the first group (UNICONE) was most often rated a 1 (40%) (Figure 1), then a 2 (38%), a 3 (16%), and a 4 (6%). No sample was rated a 5 (Table 2). In the second group (RECIPROC BLUE), the presence of the smear layer was most often rated a 2 (42%) (Figure 2), then a 1 (34%), a 3 (14%), a 4 (6%) and a 5 (4%).

(Table 2)

DISCUSSION

An effective endodontic treatment involves the complete elimination of microorganisms from the canal system and the prevention of reinfection with adequate mechanical instrumentation, irrigation, and medication [13, 17]. Numerous studies confirm that efficient canal cleaning is difficult to achieve and that the quality of cleaning is reduced starting from the crown and the middle part of the canal according to the apical segment, primarily because of the inaccessibility and inadequate diameter of the apex preparation, i.e. the reduced effect of the solution for irrigation [5, 14, 17, 18, 19].

The main aim of this study was to analyze the effects of two different systems with reciprocating movements on the quality of the cleaning of the apical part of the canal and examine the effects of individual files in the removal of the smear layer. The endodontic procedure was performed by a practitioner on simple canal systems, using the same amounts of irrigation solution (NaOCl and EDTA – which are considered to be the gold standards in hemomechanical canal preparation), and instruments with reciprocating movements (UNICONE, RECIPROC BLUE) were used according to the manufacturer's instructions and standardized irrigation procedure (the same amount and time) for each canal in both experimental groups [5, 14, 20].

The null hypothesis of this study was accepted, because the files with reciprocating movements produced similar amounts of the smear layer in the apical third of the canal in both tested groups.

In the literature, there are few studies that examined the efficiency of the files with reciprocating movements in removing the smear layer [3, 14, 21, 22, 23]. The results indicate that these files have similar cleaning effects as well as instruments with full rotation and can not provide complete cleaning of the canal system [2, 3, 21, 23].

It was also confirmed that the efficiency of the cutting of files with reciprocating movements is not influenced by the dynamics of the movement of instruments in the canal, but above all it is influenced by the design of the working part [2, 14, 22].

An attempt to align nearly all the parameters that may be of importance for the formation of the smear layer (the same diameter of the apex preparation - ISO 25, the same time and the amount of irrigants, the same irrigation technique) was made in this study, so that the decisive role in interpreting the obtained results was assigned precisely to the instruments used for the preparation of the canal.

The results of these studies pointed to a rather equable but somewhat less average value of the smear layer in the apical part of the canal after the application of the UNICONE file. Primarily, this could be explained by the design of the working part of the instrument and by the fact that larger spaces between the blades in the instruments with reciprocating movements allow more efficient elimination of the dentin debris [2, 5, 21]. These findings coincide with the results of the research where the efficiency of cleaning two systems with a single file, one with full rotation and one with reciprocating movements [3, 23], was examined. The UNICONE reciprocating file with a specific design of the working part and a different helix angle that allows efficient cutting (triangular cross-section, thermal treatment of the alloy), exceptional flexibility and improvement of the possibility of eliminating dentine debris during the canal instrumentation [2, 7, 8, 24] was used in this study.

The working part of the RECIPROC BLUE file has a S cross-sectional shape and 3 different horizontal cross-sections along working part, which, along with an inactive top, increases the efficiency of cutting and debris removal. The instrument tracks the path of minor resistance in the canal, so it is usually not necessary to create a canal passage by hand instruments [3, 22, 25, 26].

The study by Bürklein et al. [5] confirmed that continuous rotation instruments produce more smear layers and debris than systems with reciprocating movements, while SEM analysis of Poggio et al. [14] indicates that files with reciprocating movements cause the formation of larger amounts of the smear layer on the canal walls. A *well-packed* smear layer is explained by the dynamics of the instrument's movement in the canal, the reduced effect of the irrigation solution (shorter operating time for systems with one instrument), and the fact that the effect of cutting can be reduced by repeated clinical use [11, 14, 27].

The concept of canal preparation with reciprocating systems with a single instrument pointed to certain advantages (related to speed, safety, reduced fracture) in comparison with full rotation systems with multiple instruments [2, 3, 5, 11], but also disadvantages that include shortened time irrigation, reduced efficiency of the chemical debridement of the canal system and slightly more pronounced apical extrusion of dentin debris [3, 11, 26, 28]. Similar values and a little smear layer in the apical segment of the canal in the tested files with reciprocating movements, besides the design of the file, could be attributed to the enhanced activation of the irrigation solution. Actually, the dynamics of the movement of the instrument with reciprocating movements can increase the turbulence of the solution (regardless of the shorter operating time) and reduce the possibility of retaining the smear layer on the canal walls [2, 22, 28].

The studies confirm that reciprocating single-file systems provide fast and effective canal shaping with the preservation of original anatomy, significantly reduce the possibility of torsional fractures and ensure a fairly effective cleaning of the root canal system [2, 15, 27].

CONCLUSION

Within the limits of this study and based on the analyzed parameters, it can be concluded that NiTi single-file and reciprocating movement systems do not remove the smear

layer completely, but provide effective cleaning of the apical third of the canal. A small amount of the smear layer in the apical third after the application of both instruments with reciprocating movements indicates their good cleaning possibilities with simple canal systems.

Conflict of interest: None declared.

REFERENCES

1. Hülsmann M, Peters OA, Dummer PM. Mechanical preparation of root canals: shaping goals, techniques and means. Endod. Topics 2005; 10: 30-76 https://doi.org/10.1111/j.1601-1546.2005.00152.x
2. Plotino G, Ahmed HM, Grande NM, Cohen S, Bukiet F. Current Assessment of Reciprocation in Endodontic Preparation: A Comprehensive Review-Part II: properties and effectiveness. J Endod 2015;41: 1939-50. doi: 10.1016/j.joen.2015.08.018
3. Fredson Marcio Acris de Carvalho, Leonardo Cantanhede de Oliveira Gonçalves, André Augusto Franco Marques, Vanessa Alves, Carlos Eduardo da Silveira Bueno, Alexandre Sigrist De Martin. Cleaning Effectiveness of a Reciprocating Single-file and a Conventional Rotary Instrumentation System. Open Dent J 2016; 10: 704–713. doi: 10.2174/1874210601610010704 PMCID: PMC5299587
4. Al-Obaida MI, Merdad K, Alanazi MS, Altwaijry H, AlFaraj M, Alkhamis AA et al. Comparison of cyclic fatigue resistance of 5 heat-treated nickel-titanium reciprocating systems in canals with single and double curvatures. J Endod. 2019;45(10):1237-1241. doi: 10.1016/j.joen.2019.06.011.
5. Bürklein S, Hinschitza K, Dammaschke T, Schäfer E. Shaping ability and cleaning effectiveness of two single-file systems in severely curved root canals of extracted teeth: Reciproc and WaveOne versus Mtwo and ProTaper. Int Endod J 2012; 45: 449–461 https://doi.org/10.1111/j.1365-2591.2011.01996.x
6. De-Deus G, Brandão MC, Barino B, Di Giorgi K, Fidel RA, Luna AS . Assessment of apically extruded debris produced by the single-file ProTaper F2 technique under reciprocating movement. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010; 110: 390–394 https://doi.org/10.1016/j.tripleo.2010.04.020
7. Tokita D, Ebihara A, Nishijo M, Miyara K, Okiji T. Dynamic Torque and Vertical Force Analysis during Nickel-titanium Rotary Root Canal Preparation with Different Modes of Reciprocal Rotation. J Endod. 2017;43(10):1706-1710. doi: 10.1016/j.joen.2017.05.010.
8. Alcalde MP, Tanomaru-Filho M, Bramante CM, Duarte MAH, Guerreiro-Tanomaru JM, Camilo-Pinto J et al. Cyclic and torsional fatigue resistance of reciprocating single files manufactured by different nickel-titanium alloys. J Endod 2017; 43: 1186-1191 DOI: https://doi.org/10.1016/j.joen.2017.03.008
9. Kiefner P, Ban MD, De-Deus G. s the reciprocating movement per se able to improve the cyclic fatigue resistance of instruments? Int Endod J 2014; 47:430-6 https://doi.org/10.1111/iej.12166
10. de Figueiredo FED, Lima LF, Oliveira LS, Ribeiro MA, Correa MB, Brito-Junior M et al. Effectiveness of a reciprocating single file, single cone endodontic treatment approach: a randomized controlled pragmatic clinical trial. Clin Oral Investig. 2019. doi: 10.1007/s00784-019-03077-7.
11. Gambarini G, Giansiracusa Rubini A, Sannino G, Di Giorgio G, Piasecki L, Al-Sudani D et al. Cutting efficiency of nickel-titanium rotary and reciprocating instruments after prolonged use. Odontology 2016 ;104(1):77-81. doi: 10.1007/s10266-014-0183-0.
12. De-Deus G, Arruda TE, Souza EM, Neves A, Magalhães K, Thuanne E et al . The ability of the Reciproc R25 instrument to reach the full root canal working length without a glide path. Int Endod J 2013; 46(10):993-8. doi: 10.1111/iej.12091
13. Stojanović N, Krunić J, Mladenović I, Stojanović Z, Apostolska S, Živković S. Influence of different forms of calcium hydroxide and chlorhexidine intracanal medicaments on outcome of endodontic treatment of teeth with chronic apical periodontitis. Seb Arh of Medicine 2018; 146:143-148. DOI: 10.2298/SARH170221139S
14. Poggio C, Dagna A, Chiesa M, Scribante A, Beltrami R, Colombo M. . Effects of NiTi rotary and reciprocating instruments on debris and smear layer scores: an SEM evaluation. J Appl Biomater Funct Mater 2014;12(3):256-62. doi: 10.5301/jabfm.5000161.
15. Shantiaee Y, Nahvi G, Dianat O, Aghdashi F. Cervical dentin changes in curved root canals after using Wave One and Reciproc Files with full rotation versus reciprocation movement: An ex vivo Study. Contemp Clin Dent. 2017;8(3):357-362. doi: 10.4103/ccd.ccd_422_17

16. Hülsmann MR, C, Rümmelin, Schäfers F. Root canal cleanliness after preparation with different endodontic handpieces and hand instruments: A comparative SEM investigation. J Endod 1997; 23: 301-6 DOI: https://doi.org/10.1016/S0099-2399(97)80410-4
17. Sharma G, Kakkar P, Vats A. A Comparative SEM Investigation of Smear Layer Remaining on Dentinal Walls by Three Rotary NiTi Files with Different Cross Sectional Designs in Moderately Curved Canals. J Clin Diagn Res 2015;9: 43-7. doi: 10.7860/JCDR/2015/11569.5710.
18. Haapasalo M, Shen Y, Wang Z, Gao Y. Irrigation in endodontics. Br Dent J 2014;216:299-303. doi: 10.1038/sj.bdj.2014.204.
19. Guerreiro-Tanomaru JM, Loiola LE, Morgental RD, Leonardo Rde T, Tanomaru-Filho M. Efficacy of four irrigation needles in cleaning the apical third of root canals. Braz Dent J 2013;24:21-4 PMID:23657408
20. Wadhwani KK, Tikku AP, Chandra A, Shakya VK. A comparative evaluation of smear layer removal using two rotary instrument systems with ethylenediaminetetraacetic acid in different states: a SEM study. Indian J Dent Res 2011;22:10-5. doi: 10.4103/0970-9290.79967
21. Robberecht L, Dehurtevent M, Lemaitre G, Béhal H, Hornez JC, Claisse-Crinquette A. Influence of Root Canal Curvature on Wall Cleanliness in the Apical Third during Canal Preparation. Eur Endod J 2017; 2:19 DOI 10.5152/eej.2017.16035
22. De-Deus G, Marins J, Silva EJ, Souza E, Belladonna FG, Reis C et al. Accumulated hard tissue debris produced during reciprocating and rotary nickel-titanium canal preparation. J Endod 2015;41(5):676-81. doi: 10.1016/j.joen.2014.11.028
23. Živković S, Nešković J, Jovanović Medojević M et al. Efficancy of root canal cleaning using a single instrument with reciprocating motion system and full rotation systems: SEM study . Serb Dent J 2018; 65: 171-79
24. Silva EJ, Villarino LS, Vieira VT, Accorsi-Mendonça T, Antunes HD, De-Deus G et al.Bending Resistance and Cyclic Fatigue Life of Reciproc, Unicone, and WaveOne Reciprocating Instruments. J Endod 2016;42(12):1789-1793. doi: 10.1016/j.joen.2016.08.026.
25. Saber S.E.D.M, Schäfer E. Incidence of dentinal defects after preparation of severely curved root canals using the Reciproc single-file system with and without prior creation of a glide path. Int Endod J 2016; 49: 1057-64 https://doi.org/10.1111/iej.12555
26. Uslu G, Özyürek T, Yılmaz K, Gündoğar M, Plotino G. Apically Extruded Debris during Root Canal Instrumentation with Reciproc Blue, HyFlex EDM, and XP-endo Shaper Nickel-titanium Files. J Endod 2018;44(5):856-859. doi: 10.1016/j.joen.2018.01.018
27. Tavares SJO, Sarmento EB, Guimarães LDS, Antunes LAA, Antunes LS, Gomes CC. The influence of kinematics of engine-driven nickel-titanium instruments on root canal shape assessed by micro-computed tomography: a systematic review. Acta Odontol Scand. 2019;77(5):347-358. doi: 10.1080/00016357.2019.1570331.
28. Neves MA, Provenzano JC, Rôças IN, Siqueira JF Jr. Clinical Antibacterial Effectiveness of Root Canal Preparation with Reciprocating Single-instrument or Continuously Rotating Multi-instrument Systems. J Endod 2016;42(1):25-9. doi: 10.1016/j.joen.2015.09.019.

Table 1. The average values of the smear layer in the apical third of the canal

		Score of smear layer					
		N	$\bar{X}$	SD	Med	Min	Max
Group	UNICONE	100	1.88	0.89	2	1	4
	RECIPROC BLUE	100	2.04	1.04	2	1	5
	Total	200	1.96	0.97	2	1	5

Table 2. Results of the smear layer in the apical third of the canal

			Score of smear layer					Total
			1	**2**	**3**	**4**	**5**	
Group	UNICONE	N	40	38	16	6	0	100
		%	40	38	16	6	0	100
	RECIPROC BLUE	N	34	42	14	6	4	100
		%	34	42	14	6	4	100
Total		N	74	80	30	12	4	200
		%	37	40	15	6	2	100

Table 3. Results of cleaning quality in the apical third of the canal

			Score of smear layer		Total
			Clean canal	Smeared	
Group	UNICONE	N	78	22	100
		%	78	22	100
	RECIPROC BLUE	N	76	24	100
		%	76	24	100
Total		N	154	46	200

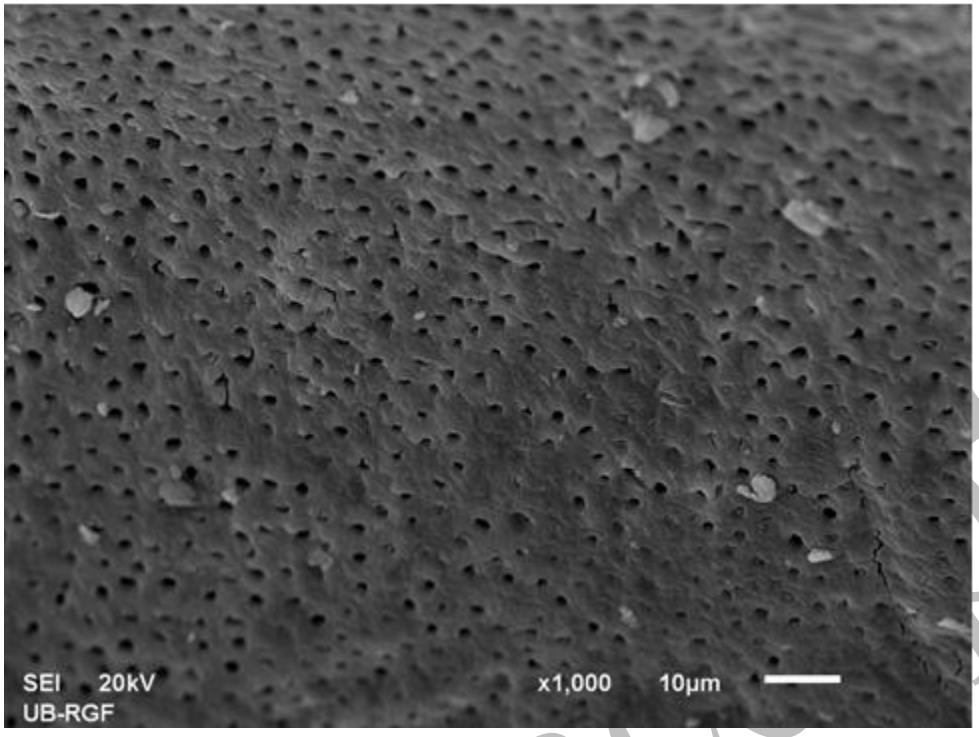

Figure 1. Microphotography of the apical third of the canal after preparation with UNICONE file / score 1 /, SEM 1000×

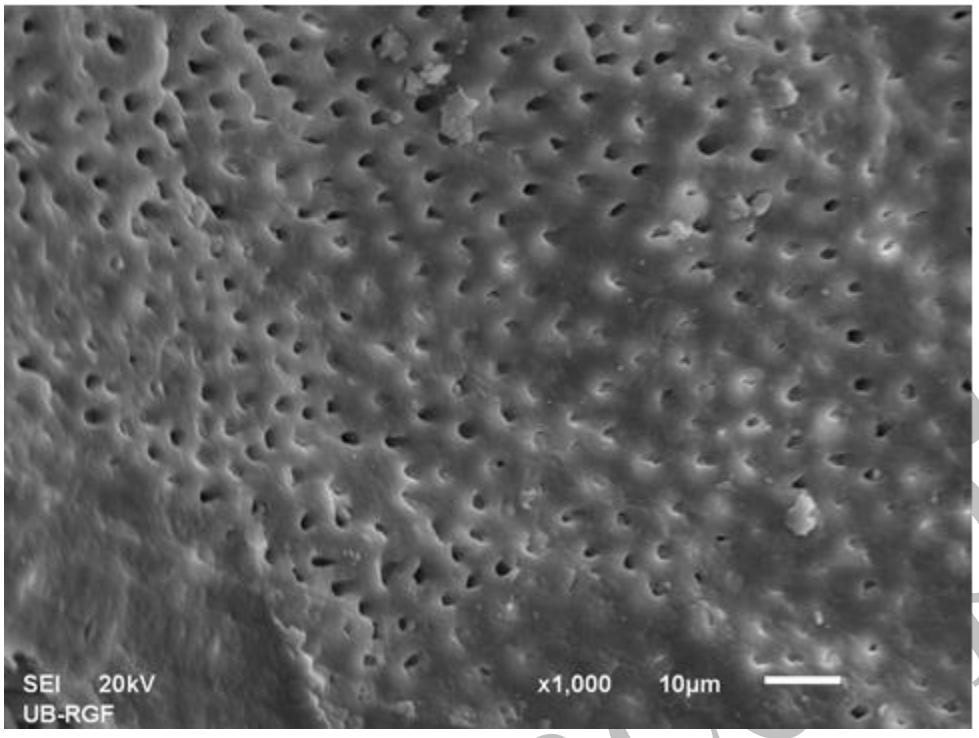

Figure 2. Microphotography of the apical third of the canal after preparation with RECIPROC BLUE file / score2 /, SEM 1000×

