UDK: 616.314.163–74

EVALUATION OF MICROLEAKAGE OF ROOT CANALS FILLED WITH TWO DIFFERENT OBTURATION TECHNIQUES: IN VITRO

ИСПИТУВАЊЕ НА МИКРОПРОТОКОТ КАЈ ЗАБИ ОБТУРИРАНИ СО ДВЕ РАЗЛИЧНИ ТЕХНИКИ НА ОПТУРАЦИЈА: IN VITRO

Cvetkova D., Rendzova V.,

Department of Restorative dentistry and Endodontics

Abstract

Introduction: The ideal root canal filling should close all communications with the periodontium, be well condensed along the entire length of the root canal space and be well adapted to the canal walls. **The aim** of this study was to compare the average apical and coronary microleakage in the root canals of teeth obturated with the warm vertical condensation method in combination with injection of liquid warm gutta-percha, and teeth obturated with single cone technique. **Materials:** 20 single-rooted human teeth with straight roots were used for this experimental study. The teeth were cleaned of tissue debris. Root canals were prepared using the coronary apical processing technique using rotating ProTaper files. The teeth were randomly divided into 2 groups of 10 teeth depending on the method of obturation (single to, and warm vertical condensation). **Results:** The results obtained from our research showed the occurrence of microfluid in all examined samples. **Conclusion:** The warm vertical condensation/ injection of liquid warm gutta-percha in combination with AH plus, if performed correctly up to the apex itself, shows a minimum microflow.
Keywords: root canal obturation, microleakage, endodontics

Апстракт

Вовед: Идеалното полнење на коренскиот канал треба да ги затвори сите излезни комуникации со пародонтот, да биде добро кондензирано низ целата должина на просторот на коренскиот канал и да биде добро адаптирано за ѕидовите на каналот. **Цел:** Целта на оваа студија беше да се спореди просечното апикално и коронарно микропротекување во коренските канали кај заби обтурирани со методот на вертикална кондензација во комбинација со инјектирање на течна толпла гутаперка и заби оптурирани со сингл кон техника на оптурација. **Материјали:** За оваа експериментална студија беа користени 20 еднокорени хумани заби со прави корени. Забите беа исчистени од ткивни остатоци. Коренските канали беа подготвени со помош на коронарно апикалната техниката на обработка со помош на ротациони ProTaper фајлови. Забите по случаен избор беа поделени во 2 групи од по 10 заби во зависност од начинот на оптурација (сингл кон и топла вертикална кондензација). **Резултати:** Резултатите добиени од нашето истражување покажаа појава на микропроток кај сите испитувани примероци. **Заклучок:** Оптурацијата со Fast Fill во комбинација со AH plus, доколку е коректно изведена до самиот апекс покажува минимум микропроток.
Клучни зборови: канална оптурација, микропроток, ендодонција.

Introduction

The objective of root canal filling is preventing microorganisms and their products to pass along the root canal, providing the body with conditions for biological healing through apical sealing and healing of periapical tissues[1].

The success of endodontic therapy depends on shaping and cleaning of the root canal system followed by three-dimensional obturation with perfect coronal and apical seal including accessory canals[2].

An ideal root canal filling should seal all portals of exit to the periodontium, be well condensed throughout the length of the root canal space and be in close adaptation to the walls of the canal.

Apical seal is considered to be the most crucial factor for the success of a root canal treatment. Dow and Ingle suggested that 60% of root canal treatment failures can be attributed to re-entry of microorganisms from the peri-radicular area into the incompletely obturated root canals[3,4].

Although numerous materials have been used for obturation, the most commonly used material is still gutta-percha[5]. The single cone obturation technique has been often regarded as inadequate due to its potential for apical leakage[6]. In the single cone technique, the root

canal is generally obturated with a fitted cone that matches the shape (taper and apical gauge) of the last rotary instrument used in combination with large quantity of sealer[7].

Modern techniques of root canal obturation are routinely accomplished with the use of either "cold" or "warm" gutta-percha condensation techniques in combination with a sealer which acts as a lubricant, helping seal off voids and potentially seal any accessory canal[8].

Obturation systems have been developed using heat-softened gutta-percha delivered via injection or with a carrier which delivers heat to cold gutta-percha cones cemented in the canal[9].

The aim of this stady

The aim of this study was to compare the mean apical and coronar microleakage in root canals of extracted teeth obturated with the warm vertical condensation method, and thermoplasticised

Material and methods

For this experimental study, 20 single-rooted human mandibular premolar teeth with straight roots were collected. The teeth were cleaned from periodontal tissue appendages and immersed in 2.5% sodium hypochlorite solution for 30 minutes. The teeth were stored in normal saline solution until the experiments (maximum of one month).

The working length was determined using #15 k file (Mani, Japan) 0.5mm shorter than the apex. Root canals were prepared using the crown down technique and ProTaper rotary files (Dentsply, Tulsa Dental Specialties, Tulsa, OK) up to F2 MAF according to the manufacturer's instructions for the speed and torque of ProTaper files working with endomotor. Each rotary file was used for preparation of 5 canals only. A 2,5% sodium hypochlorite solution was used to irrigate the canals between usages of each instrument and after completion of instrumentation. The canals were then dried. The teeth were divided into 2 groups of 10 teeth depending on the method of obturation.

The root canals from the first group were obturated with the method of vertical condensation in the apical third in combination with a warm thermoplasticised injectable gutta-percha for the middle and coronary third. The teeth from the second group were obturated with single cone technique with F2 gutta-percha points (Dia-ProT, DiaDent) according to the last used file. We used AH plus as a siler in both groups.

All teeth surfaces except for the coronal and apical 2mm were covered with 2 layers of nail varnish.

All teeth were stored at 37°C and 100% moisture for 1 week to ensure the setting of the sealer. All specimens were immersed in 2.0% methylene blue at 37 °C for 24 hours, after which they were washed and dried. The teeth were then sectioned longitudinally in a buccolingual direction using a slow speed diamond saw. Linear apical dye penetration was measured for each specimen using Stereomicroscope at X10 magnification.

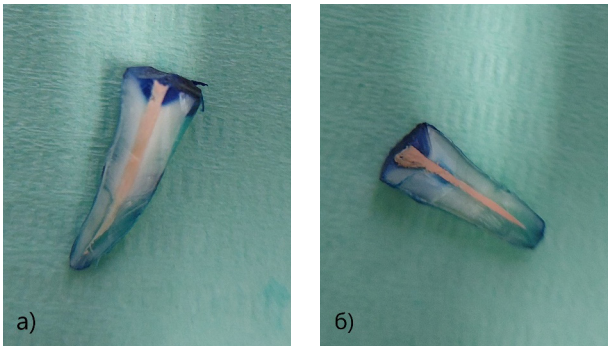

Figure 1. *a) warm vertical condensation, b) single cone technique*

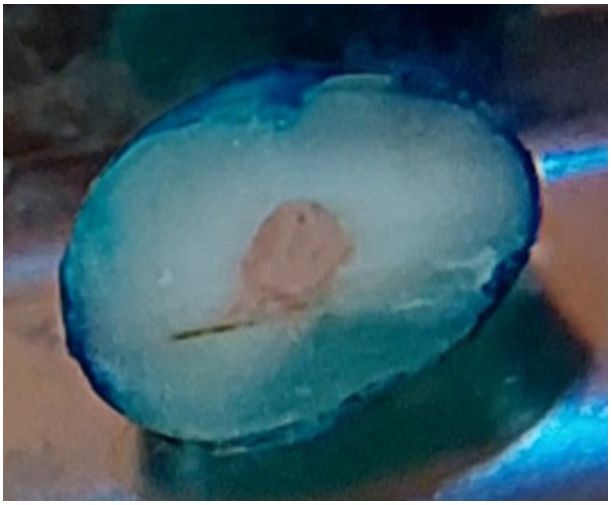

Figure 2. *Cross section of the coronary third of a tooth obtuse with warm vertical condensation*

Independent Sample t-test was applied to compare micro leakage values in the two study groups. Level of significance was kept at 0.05.

Results

The results obtained from our research showed occurrence of microleakage in all examined samples.

In both examined groups, in relation to the length of the root canal, a larger microleakage was observed in the coronary third of the root canals.

Tabela 1.

	Group	No. of canals	Minimum mm	Maximum mm	Mean mm	S.D
Apical	1	10	0.1	1.8	0.95	0.540
Leakage	2	10	0.5	2	1.11	0.509
Coronary	1	10	0.5	2	1.02	0.461
Leakage	2	10	1	2.5	1.52	0.442

When comparing the microleakage between the two examined groups in the apical third, the obtained results showed values for P equal to 0.5039, which indicates that there is no statistically significant difference in the microcurrent in the apical third.

When comparing the microcurrent between the two examined groups in the coronary third, the obtained results showed values for P equal to 0.0235, i.e. statistically significantly higher microleakage in the teeth of the second group obturated with single to the obturation technique.

Discussion

It is known that adequate root canal obturation without gaps, and the possibility of microleakage is associated with more successful outcomes after root canal treatment.

Dye penetration tests are favored as they are cost effective and easier to perform with minimum armamentarium. The use of 2.0% methylene blue has been the concentration mostly employed in leakage studies. At this concentration it is detectable under visible light, is water soluble, easily diffusible but at the same time no uptake by the dentine matrix has been observed[10].

Methylene blue was also the preferred choice because it has a molecular size that is comparable to a few bacterial by-products, e. g. butyric acid, that has been reported to leak from the infected root canal space into the periapex, causing irritation in the periapical tissues[11].

This study was designed to evaluate the quality of root canal obturation in straight single-rooted teeth by assessing coronary and apical microleakage in root canals obturated with a single cone t technique and the technique of warm vertical compaction in combination with a thermoplasticised gutta-percha.

The contraction of the gutta-percha and the lack of adhesion of the filler materials to the walls of the root canal are factors that create sufficient predispositions for microleakage. The sealer is essential for all obturation techniques. Although the behavior of different sealers and the obturation technique may differ, studies show that the gutta-percha without sealer does not have an adhesive ability to the walls of the root canal[8].

Low solubility of root canal sealers has been introduced as a requirement in the International standard ISO 6876 for root canal sealing materials.

All root canal filling materials allow marginal infiltration. They are not impenetrable[13,14]. For AH plus the most favorable and predictable results are obtained if the root canal system is as dry as possible before obturation [15,16].

In our research we used single cone technique and the technique of vertical condensation of the gutta-percha for the root canal obturation, and in both applied obturation techniques we used AH plus as a sealer.

The simplicity of the single cone technique is the main advantage of this obturation technique. The single cone technique allows the use of a single gutta-percha cone with shape and size corresponding to the final shape of the root canal, and works as a key and lock system. Currently, this method is used by several mechanical instrumentation systems. However, a research by several authors suggests that this obturation technique is inferior to other techniques when it comes to microleakage. According to some studies, the single cone technique provides inadequate obturation especially in oval root canals[17,18].

The Fast fill system is a thermoplasticised gutta-percha system in which gutta-percha pellets are put in a delivery gun and expressed into the root canal space once heated to a temperature of 200 °C. To compensate for the shrinkage associated with cooling of the gutta-percha that would clinically manifest as voids in the obturation material on radiographic examination, compaction after 3–4 mm of incremental placement of gutta-percha is advocated before subsequent increment is injected[19].

This recommended protocol was followed in this study to prevent the formation of voids that might otherwise result from α-gutta-percha contraction upon cooling.

The results of this study showed that in the apical third there was no statistically significant difference in the microleakage of the teeth obturated with the single technique and with warm vertical compaction technique of the gutta-percha. In our study, root canals were shaped with ProTaper instruments and obturated with a sealer and

gutta-percha that matched the size of the last instrument used. According to the manufacturer but also according to some authors, ProTaper gutta-percha cones fit perfectly into the root canals shaped with the instruments of this system[20].

The results obtained from our research are in accordance with the results presented by several authors[20, 21,22].

Namely Tasdemir T et al. comparing the sealing ability of the single con, lateral condensation and warm vertical condensation techniques when working with two instrumentation systems, concluded that all three examined obturation techniques showed similar sealing effects in the apical third[22].

On the other hand, inferior results of single-cone obturation have been reported by Yücel and Çiftçi. They concluded that the poor seal with the Single-cone ProTaper gutta-percha may be related to the technique itself as the gutta-percha is not compacted but is only inserted to the working length with a substantial amount of sealer[23]. Monticelli et al. compared contemporary single-cone root filling techniques with warm vertical compaction and concluded that the warm vertical compaction provided more durable apical seal[24].

When examining the microleakage in the cervical third, the results from our research showed that there is a greater microleakage in teeth filled with a single cone technique compared to teeth filled with a fast filling system. Namely, by using the Fast fill method, the heated gutta-percha adapts more easily to the irregular parts of the root canal. In addition, in the vertical condensation technique, the gutta-percha condensation in the cervical third is more direct due to easier access, optimizing the adaptation of the filling material in this part of the root canal. The results presented in our study are consistent with the results presented by Iglecias et al. Namely examining the presence of voids in the root canal filling by computed tomography, they concluded that the lowest percentage of cavities was found in the coronary thirds of the group of teeth treated with vertical condensation, compared to the single cone technique. The difference in the volume of the gaps in the middle and apical third between the two obturation techniques was negligible[25].

According to Ozawa, the obturation technique has little effect on the quality of the apical third obstruction, while the thermoplastic gutta-percha application technique provides better adaptation of the gutta-percha in the canal space, the presence of a smaller amount of sealer, and thus a lower chance of occurrence of microleakage in the middle and coronary third[21].

Better obturation in the coronary third contributes to the improvement of coronary sealing, which reduces the accidental microleakage of microorganisms through the root canal system into periapical tissues. The coronary third is the first barrier between coronary restoration and root canal filling material.

Reference

1. European Society of Endodontology. Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontology. Int Endod J. 2006 Dec;39(12):921-30.
2. Grga D, Dželetović B, Miletić V, Damjanov M. Water Uptake and Solubility of Acroseal Sealer in Comparison with Apexit and AH Plus Sealers in Hank's Solution. Srp Arh Celok Lek. 2011;139(10):579–582. https://doi.org/10.2298/SARH1110579G
3. Dow PR, Ingle JI. Isotope determination of root canal failure. Oral Surg Oral Med Oral Pathol 1955; 8: 1100–4.
4. Ingle JI, Bakland LK. Endodontics. 5th ed. London: BC Decker Inc.; 2002.
5. Carotte P. Endodontics: Part 8. Filling the root canal system. Br Dent J 2004; 197: 667–72.
6. Pommel, L.; Camps, J. In vitro apical leakage of system B compared with other filling techniques. J. Endod. 2001, 27, 449–451.
7. Heran, J.; Khalid, S.; Albaaj, F.; Tomson, P.L.; Camilleri, J. The single cone obturation technique with a modified warm filler. J. Dent. 2019, 89, 103181.
8. Castagnola, R.; Marigo, L.; Pecci, R.; Bedini, R.; Cordaro, M.; Liborio Coppola, E.; Lajolo, C. Micro-CT evaluation of two different root canal filling techniques. Eur. Rev. Med. Pharmacol. Sci. 2018, 22, 4778–4783.
9. Glickman GN, Koch KA. 21st century endodontics. J Am Dent Assoc 2000; 131 (Suppl): 39S–46S.
10. Limkangwalmongkol S, Burtscher P, Abbott PV, Sandler AB, Bishop BM. A comparative study of the apical leakage of four root canal sealers and laterally condensed guttapercha. J Endod 1991;17(10):495–9.
11. Punia SK, Nadig P, Punia V. An in vitro assessment of apical microleakage in root canals obturated with gutta-flow, resilon, thermafil and lateral condensation: A stereomicroscopic study. J Conserv Dent 2011;14(2):173–7. 14.
12. Bodrumlu E, Tunga U. Apical leakage of Resilon obturation material. J Contemp Dent Pract 2006;7(4):45–52.
13. Balguerie E, Van Der Sluis L, Vallaeys K, GurgelGeorgelin M, Diemer F. Sealer penetration and adaptation in the dentinal tubules: A scanning electron microscopic study. J Endod. 2011;37(11):1576–1579. https://doi.org/10.1016/j.joen.2011.07.005
14. Drukteinis S, Peciuliene V, Maneliene R, Bendinskaite R. In vitro study of microbial leakage in roots filled with EndoREZ sealer/EndoREZ Points and AH Plus sealer/conventional gutta-percha points. Stomatologija. 2009;11(1):21–25.
15. Johnson J david. Root canal filling materials. In: Ingle JI, Bakland, Baumgartner, editors. Ingle's Endodontics. 6th ed. Hamilton, Ontario: BC Decker Inc; 2008. p. 1041. 28.
16. Eldeniz AU, Ørstavik D. A laboratory assessment of coronal bacterial leakage in root canals filled with new and conventional sealers. Int Endod J. 2009;42:303–312. https://doi.org/10.1111/j.1365-2591.2008.01509.x
17. Hörsted-Bindslev P, Andersen MA, Jensen MF, Nilsson JH, Wenzel A. Quality of molar root canal fillings performed with the lateral compaction and the single-cone technique. J Endod 2007;33:468–71. 24.
18. Robberecht L, Colard T, Claisse-Crinquette A. Qualitative evaluation of two endodontic obturation techniques: tapered single-cone method versus warm vertical condensation and injection system—an in vitro study. J Oral Sci 2012;54:99–104.
19. Maham Muneeb Lone Farhan Raza Khan. Evaluation Of Micro

Leakage Of Root Canals Filled With Different Obturation Techniques: An In Vitro Study. J Ayub Med Coll Abbottabad Jan-Mar 2018;30(1):35-39.
20. Inan U, Aydin C, Tunca YM, Basak F. In vitro evaluation of matched-taper single-cone obturation with a fluid filtration method. J Can Dent Assoc. 2009 Mar;75(2):123-123c.
21. Toshiko Ozawa , Nessrin Taha, Harold H Messer. A comparison of techniques for obturating oval-shaped root canals. Dent Mater J. 2009 May;28(3):290-4. doi: 10.4012/dmj.28.290.
22. Tasdemir T, Yesilyurt C, Ceyhanli KT, Celik D, Er K. Evaluation of apical filling after root canal filling by 2 different techniques. J Can Dent Assoc. 2009 Apr;75(3):201-201d.
23. Yücel AÇ, Çiftçi A. Effects of different root canal obturation techniques on bacterial penetration. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006 Oct;102(4):e88-92.
24. Monticelli F, Sadek FT, Schuster GS, Volkmann KR, Looney SW, Ferrari M et al. Efficacy of two contemporary single-cone filling techniques in preventing bacterial leakage. J Endod. 2007 Mar;33(3):310-3.
25. Elaine Faga Iglecias 1, Laila Gonzales Freire 1, George Táccio de Miranda Candeiro 1, Marcelo Dos Santos 1, João Humberto Antoniazzi 1, Giulio Gavini 2 Presence of Voids after Continuous Wave of Condensation and Single-Cone Obturation in Mandibular Molars: A Micro-Computed Tomography Analysis Journal of Endodontics. April 2017, Volume
43. Issue 4, Pages 638-642. https://doi.org/10.1016/j.joen. 2016.11.027