How to Cite:
Tomar, D., Sarin, J., Sharma, A., Sharma, N., Arora, P., & Kumar, P. (2022). Effects of various agitation techniques on sealer penetration in dentinal tubules using CLSM: An in-vitro study. *International Journal of Health Sciences*, *6*(S6), 5352–5359. https://doi.org/10.53730/ijhs.v6nS6.10652

Effects of various agitation techniques on sealer penetration in dentinal tubules using CLSM: An in-vitro study

Dr. Deeksha Tomar
Senior Lecturer, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College and Research Centre, Ghaziabad, Uttar Pradesh, India
*Corresponding author email: deeksha.tomar04@gmail.com

Dr. Jyoti Sarin
Reader, Department of Periodontology, Shree Bankey Bihari Dental College and Research Centre, Ghaziabad, Uttar Pradesh, India

Dr. Apoorva Sharma
Senior Lecturer, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College and Research Centre, Ghaziabad, Uttar Pradesh, India

Dr. Nikita Sharma
Senior Lecturer, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College and Research Centre, Ghaziabad, Uttar Pradesh, India

Dr. Pulkit Arora
Senior Lecturer, Department of Conservative Dentistry and Endodontics, Shree Bankey Bihari Dental College and Research Centre, Ghaziabad, Uttar Pradesh, India

Dr. Puneet Kumar
Professor and Head, Department of Public Health Dentistry, Shree Bankey Bihari Dental College and Research Centre, Ghaziabad, Uttar Pradesh, India

Abstract---Aim: To compare the effect of ultrasonic, sonic and rotary sealer activation techniques on depth of penetration of sealer in the dentinal tubules. Materials and Methods: Freshly extracted 60 single rooted human permanent mandibuar premolar with mature apex were collected. A size 10 no. K file (Dentsply Maillefer) was introduced into each canal. The irrigation procedure was accomplished by using 2ml of 5.25% NAOCl for each file used. Roots were randomly divided into 3

groups on the basis of sealer activation techniques. The specimens were kept in incubator at 37 degree Centigrade temperature for 2 days. The dentin segments were examined on a confocal microscope in Jawaharlal Nehru University, New Delhi under 4X,10X magnification. Results: A total of 60 teeth were included in the study and they were divided into three groups on the basis of method of agitation of sealer: GROUP I - Lentulospiral, Group II-Ultrasonic endodontic tip, Group III - Endoactivator and obturation was done with gutta percha. Mean percentage and depth of penetration was greatest in Group II i.e. Ultrasonics when used for agitation and statistically significant than Group I lentulospiral and Group III Endoactivator. Conclusion: The maximum depth and percentage of penetration of a novel Root canal sealer Bioroot RCS (Septodent) by different agitation techniques at different section levels was measured in the present study by Confocal Laser Scanning Microscopy (CLSM). Bioceramic based root canal sealer used in our study has shown significantly better depth and percentage of penetration with ultrasonics sealer placement technique compared to other techniques in our study.

Keywords---sealer, endoactivator, obturation, NAOCl.

Introduction

Three dimensional obturation of the root canal is the prime goal of endodontic therapy. Obturation eliminates all avenues of leakage from the oral cavity and the periradicular tissues into the root canal system by creating a fluid-tight seal. Gutta percha is the "gold standard" obturating material with disadvantage of being non adherent to canal walls.[1,2] The combination of gutta-percha (GP) and an endodontic sealer is usually employed for root canal filling. Sealer is important to the integrity of the obturation of the canal space. Endodontic sealers are used in conjunction with core filling materials in order to avoid gaps and voids. According to Various studies penetration of sealer into dentinal tubules will increase the interface between the filling material and dentin thus improving the sealing ability and the retention of material by mechanical locking.[3,4,5] Researchers have found that with these recent sealer placement techniques, sealer is able to reach every nook and corner of the canal.[6,7,8,9] Now a days newer techniques like ultrasonic activation, rotary and endoactivator systems have also been introduced and widely accepted. This study has been done to evaluate the efficiency of various sealer activation techniques. The transmission of acuostic microstreaming from an oscillating file by the use of ultrasonic activation can promote greater tubular penetration and improved interfacial adaptation between the sealer and root canal walls. Whereas Agitation with lentulospiral, rotates the sealer centrifugally and Endoactivator systems is used by the application of sonic energy.

These three sealer placement techniques will be used for the penetration of sealer. In comparison to conventional SEM, CLSM has the advantage of giving better details of images with less reflection. So, in the present study a Novel endodontic newer generation sealer BioRoot™ RCS based on tricalcium silicate materials

benefiting from Active Biosilicate Technology is being placed into canals with rotary, sonic and ultrasonic agitation techniques. It is recognized as bioactive material through their capacity to induce hard tissue formation. It possess the properties of biocompatibility, hydroxyapatite formation, mineralization of dentinal structure, alkaline pH and good sealing properties.

Materials and Method

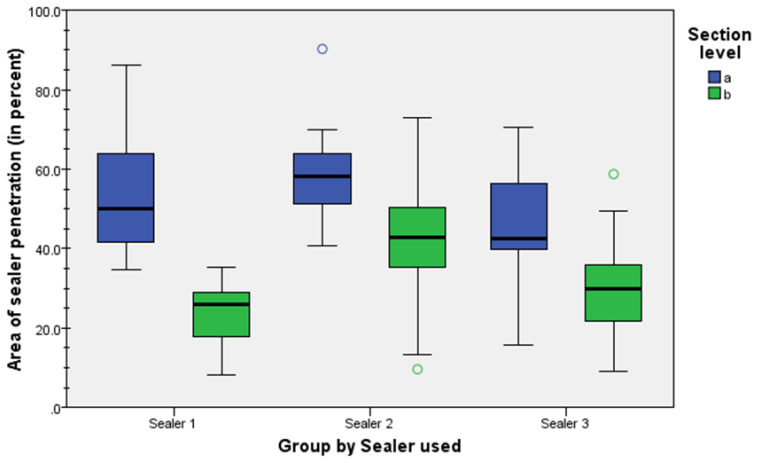
The objectives of the study were 1) to study the effect of penetration of a novel root canal sealer Bioroot RCS (septodent) using Ultrasonic sealer agitation technique, 2) to study the effect of penetration of a novel root canal sealer Bioroot RCS (septodent) using Lentulospiral (Rotary) sealer agitation technique, 3) to study the effect of penetration of a novel root canal sealer Bioroot RCS (septodent) using Endoactivator (Sonic) sealer. For specimen selection, freshly extracted 60 single rooted human permanent mandibuar premolar with mature apex were collected. Shaping and cleaning of root canal system was attempted. For standardization of root length (12 mm) the crown resection was done with a diamond disc in a slow speed contra angle handpiece under constant water cooling. A size 10 no. K file (Dentsply Maillefer) was introduced into each canal until it is seen through the apical foramen and appropriate length measured. Working length was established by subtracting 0.5mm from that length. The roots were instrumented by using the ProTaper Universal root canal rotary files (Dentsply Maillefer) in a sequential manner from S1 till F2. Entire bio-mechanical preparation was done with ProTaper Universal root canal rotary files under copious irrigation using 5.25% NaOCl (Vishal industries Pvt Ltd.). The irrigation procedure was accomplished by using 2ml of 5.25% NAOCl for each file used. To remove Smear layer canals were irrigated with 3 ml of 17% EDTA (Prevest) solution for 3min. followed by rinsing with 2 ml distilled water. Roots were randomly divided into 3 groups on the basis of sealer activation techniques. Group1-(Rotary) A size thirty lentulospiral (Dentsply) was selected that would not bind in the prepared canal.

Group 2- (Ultrasonic) The ultrasonic unit (Satelac) was used in endo mode with ultrasonic endodontic tip K15 Sonofile (Satelac) for activation. Group 3-(Sonic) Endoactivator tip (Dentsply) of size 30 was set to reach 2mm short of working length and slowly activated. For sealer application, Biroot RCS sealer (Septodent) was mixed according to the manufacturer instructions and to allow analysis under the Confocal laser scanning microscopy, sealer was mixed with the Rhodamine B dye (Avarice Industries) to an approximate conc. of 0.1% (by weight) prepared with the help of biochemistry laboratory personnel. A 1m tuberculin syringe (Sun surgical supply) was used to dispense 0.05ml of sealer into the canal and the walls of the canal were coated with the help of finger spreaders. No additional sealer to be used. Group1-The lentulospiral (Dentsply Maillefer) was rotated at speed of 300 rpm keeping the instrument 2mm short from apex for 20 seconds. Group2-The ultrasonic unit (Satelac) was used in endo mode with ultrasonic endodontic tip K15 Sonofile (Satelac) for activation. Group3-Endoactivator (Dentsply Maillefer) tip of size 30 was set to reach 2mm short of working length and slowly rotated for 20 seconds.

After sealer placement obturation will be done in the same manner as in other groups. The specimens were kept in incubator at 37 degree Centigrade temperature for 2 days. Each root will be sectioned at 90° to the long axis by using diamond disc removing 1-2mm of sections at 4mm and 8mm from the apex under continuous irrigation. Coronal surface of each section was polished with sand paper and placed on a slide (Blue Star, Polar industrial corporation Mumbai) covered with a cover slip attached to the slide with an adhesive (available by the name 'Feviquick' in the market). The dentin segments were examined on a confocal microscope (Olympus fluoview FV 1000) in Jawaharlal Nehru University, New Delhi under 4X, 10X magnification.

Results

The present study was carried out to measure the depth and percentage of penetration of Bioroot RCS root canal sealer (Septodent) by three different agitation techniques. A total of 60 teeth were included in the study and they were divided into three groups on the basis of method of agitation of sealer: GROUP I - Lentulospiral, Group II-Ultrasonic endodontic tip, Group III - Endoactivator and obturation was done with gutta percha. Horizontal sections at 4mm and 8mm from the apex were obtained and the depth and percentage of penetration were measured using Confocal Laser Scanning Microscope (CLSM). All data was subjected to statistical analysis {(One Way Anova test) and (Post hoc test 'Bonferroni')}. Mean percentage and depth of penetration was greatest in Group II i.e. Ultrasonics when used for agitation and statistically significant than Group I lentulospiral and Group III Endoactivator. Irrespective of the method of sealer agitation the percentage and depth of sealer penetration were greater at coronal sections (a section) than at apical sections (b sections).



Graph 1. Showing Comparison of Percentage of Sealer penetration by each group

Discussion

One of the objectives of root canal treatment is to provide a hermetic seal of root canal space. This seal is usually produced by using a semisolid or solid core material in a combination with the endodontic sealer. A solid core cannot produce the desired hermetic seal.[10,11] Thus, the endodontic sealer is required to provide three dimensional obturation. Removal of smear layer and use of sealer to attain and impervious seal between the core material and root canal walls is considered an essential step of root canal treatment.[12,13] Sealers which can penetrate into the dentinal tubules exert bactericidal effect by having a closer contact with the residual bacteria within the tubules. In addition, sealer plugs inside the dentinal tubules provide a mechanical interlocking, thereby improving the retention of the filling material and reducing the microleakage along the root canal walls.[14,15] Thus, both percentage and depth of sealer penetration might influence the outcome or success rate of endodontic therapy.

Factors influencing sealer depth penetration in dentinal tubules are presence/absence of dentinal permeability (the number and the diameter of tubules), root canal dimension, presence of water, and physical and chemical properties of the sealer.[16,17,18] Now a day's newer techniques like ultrasonic activation, rotary and endoactivator systems have also been introduced and widely accepted.Thus in this study evaluation of the efficiency of these sealer activation techniques has been done and penetration has been analyzed. The results of this study indicate that all three methods of sealer placement may not consistently and completely cover dentin walls after lateral condensation. Over all ultrasonic group (Gr2) showed better depth and percentage of sealer penetration than lentulospiral (Gr1) followed by endoactivator group (Gr3). Application of ultrasonics for activation led to significantly more percentage and depth of both the sealer and is accordance to Guimaraes BM et al.[19] The ultrasonic and sonic energy apparently propels the relatively viscous sealer along the length of file to appropriate Depth.while lentulo spiral centrifugally pushes the sealer. Sonic energy generates significantly higher amplitudes and lesser frequency or great back and forth tip movement compare toultrasonically driven instruments.[20]

Also sonic energy produces just one single node and antinode over the entire length of vibrated instrument so the streaming velocity is less than the ultrasonic devices. Node production along activated file is an important part of acoustic Streaming. Resulting in a strong current produce along the activated instrument.[21] Ultrasonic energy has the ability to create several nodes along the length of file. The explanation for this is that the oscillating files in ultrasonics transmits the acoustic micro streaming energy and cause a greater depth of dentinal sealer penetration and coverage of root canal walls in the same manner as it promotes the penetration of irrigants in an area of anatomic complexities and the dentinal tubules. Thus in accordance to other studies use of ultrasonics results in better sealer placement than other compared techniques utilized in the study. The transmission of acuostic micro-streaming from an oscillating file by the use of ultrasonic activation can promote greater tubular penetration and improved interfacial adaptation between the sealer and root canal walls.[22,23] Whereas Agitation with lentulospiral, rotates the sealer centrifugally and Endoactivator systems is used by the application of sonic energy. These three

sealer placement techniques were used for the penetration of sealer. Amount of sealer, extent of activating instrument, and time for activation were standardized to minimize the errors.

A novel Bioceramic-based Bioroot RCSHas been recently introduced as root canal sealer and is being used in this study. BioRoot™ RCS is the newest endodontic sealer based on tricalcium silicate materials benefiting from both Active Biosilicate Technology.[24] BioRoot™ RCS is indicated for the permanent root canal filling in combination with gutta-perchapoints and is suitable for use in single cone technique or cold lateral condensation (Camilleri, 2015).[25] In addition, BioRoot™ RCS displayeda tight seal with the dentin and the gutta-percha and an appropriate radiopacity. The paste is of smooth consistency with good flow and adequate adhesion to instruments in order to enable an optimal placement in the root canal. Thanks to the use of Active BioSilicate Technology which is monomer free, there is no shrinkage of BioRoot™ RCS during setting to allow a tight seal of the root canal. Several microscopy techniques are currently used to evaluate the sealer/dentin interface, including stereomicroscopy.[26,27] CLSM offers several advantages over conventional SEM. It provides detailed information about the presence and distribution of sealers or dental adhesives inside dentinal tubules in the total circumference of the root canal walls at relative low magnification through the use of fluorescent Rhodamine marked sealers and artifacts could practically be excluded.

Conclusion

It is known that bioceramic based rootcanal sealers are bioactive and have osteogenic potential because of their nanoparticles. The maximum depth and percentage of penetration of a novel Root canal sealer Bioroot RCS (Septodent) by different agitation techniques at different section levels was measured in the present study by Confocal Laser Scanning Microscopy (CLSM). Bioceramic based root canal sealer used in our study has shown significantly better depth and percentage of penetration with ultrasonics sealer placement technique compared to other techniques in our study. Within the limitations of this study it is concluded that Bioroot RCS with ultrasonic sealer placement technique has better penetration and thus is likely to give best results in patients requiring such sealer use for three dimensional obturation and making hermatic seal at the apex.

References

1. Abarajithan M, Dham S, Velmurugan N, Valerian-Albuquerque D, Ballal S, Senthilkumar H. C of E irrigation system with conventional irrigation for removal of intracanal smear layer: An in vitronstudy. OSOMOPORE. 2011;112:407–11.
2. Akcay M, Arslan H, Durmus N, Mese M, Capar ID. Dentinal tubule penetration of AH Plus, iRoot SP, MTA fillapex, and guttaflow bioseal root canal sealers after different final irrigation procedures: A confocal microscopic study. Lasers Surg Med. 2016;48:70–6.
3. Boutsioukis C, Lambrianidis T. KEI flow within a prepared root canal using various flow rates: A CFD study. IEJ. 2009;42:144–55.

4. Camilleri J. Sealers and warm gutta-percha obturation techniques. J Endod. 2015;41(1):72–78.
5. Castagnola R, Lajolo C, Minciacchi I, Cretella G, Foti R, Marigo L, et al. Efficacy of three different irrigation techniques in the removal of smear layer and organic debris from root canal wall: A scanning electron microscope s SFE of three different irrigation techniques in the removal of smear layer and organic debris from root canal wall: A scanning electron microscope study. GIE. 2014;28:79–86.
6. Chandra SS, Shankar P, Indira R. Depth of penetration of four resin sealers into radicular dentinal tubules: A confocal microscopic study. J Endod. 2012;38:1412–6.
7. Desai P, Himel V. Comparative safety of various intracanal irrigation systems? J Endod. 2009;35:545–9. doi: 10.1016/j.joen.2009.01.011.
8. Generali L, Prati C, Pirani C, Cavani F, Gatto MR, Gandolfi MG. D dye technique and fluid filtration test to evaluate early sealing ability of an endodontic sealer. COI. 2016;21:1267–76.
9. Gu LS, Kim JR, Ling J, Choi KK, Pashley DH, Tay FR. Review of contemporary irrigant agitation techniques and devices. J Endod. 2009;35:791–804.
10. Guimarães BM, Amoroso-Silva PA, Alcalde MP, Marciano MA, de Andrade FB, Duarte MA. Influence of Ultrasonic Activation of 4 Root Canal Sealers on the Filling Quality. J Endod 2014;40:964-968.
11. Howard RK, Kirkpatrick TC, Rutledge RE, Yaccino JM. Comparison of debris removal with three different irrigation techniques. J Endod. 2011;37:1301–5.
12. Khademi A, Yazdizadeb M. FD of the MIS for P of I to the AT of RCS. JE. 2006;32:417–20.
13. Moon YM, Shon WJ, Baek SH, Bae KS, Kum KY, Lee W. E of final irrigation regimen on sealer penetration in curved root canals. JE. 2010;36:732–6.
14. Munoz HR, Camacho-Cuadra K. In vivo efficacy of three different endodontic irrigation systems for irrigant delivery to working length of mesial canals of mandibular molars. J Endod. 2012;38:445–8.
15. Nielsen BA. BJC of the E system to needle irrigation of root canals. JE. 2007;33:1–5.
16. Nikhil V, Bansal P. SSE of technique of sealer agitation on percentage and depth of MF sealer penetration: A comparative in-vitro study. JCD. 2015;18:119–23.
17. Nikhil V, Singh R. Confocal laser scanning microscopic investigation of ultrasonic, sonic, and rotary sealer placement techniques. J Conserv Dent. 2013;16:294–9.
18. Ordinola RZ, Monteiro CB, Marcia S. D and percentage of penetration of endodontic sealers into dentinal tubules after root canal obturation using a lateral compaction technique: A confocal laser scanning microscopy study. OSOMOPORE. 2009;108:450–7.
19. Patel DV, Sherriff M, Ford TR, Watson TF. MFT penetration of R primer and T into root canal dentinal tubules: A confocal microscopic study. IEJ. 2007;40:67–71.
20. Saber SE. HAE of different final irrigation activation techniques on smear layer removal. JE. 2011;37:1272–5.

21. Saleh IM, Ruyter IE. Haapasalo M/ØDS of E faecalis in infected dentinal tubules after root canal filling with different root canal sealers *in vitro*. IEJ. 2004;37:193–8.
22. Sen BH, PisKin B, Baran N. The effect of tubular penetration of root canal sealers on dye microleakage. IEJ. 1996;29:23–8.
23. Siu C. BJC of the debridement efficacy of the E irrigation system and conventional needle root canal irrigation *in vivo*. JE. 2010;36:1782–5.
24. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Health and treatment of diabetes mellitus. *International Journal of Health Sciences*, *5*(1), i-v. https://doi.org/10.53730/ijhs.v5n1.2864
25. Tay FR, Gu LS, Schoeffel GJ, Wimmer C, Susin L, Zhang K, et al. E of vapor lock on root canal debridement by using a side-vented needle for positive-pressure irrigant delivery. JE. 2010;36:745–50.
26. Torres D, Rodriguez MP. LCE of the E system in removing the smear layer after root canal instrumentation. JE. 2010;36:308–11.
27. Weis MV, Parashos P, Messer HH. Effect of obturation technique on sealer cement thickness and dentinal tubule penetration. Int Endod J. 2004;37:653–63.
28. Weis MW, Parashos P. MHE of obturation technique on sealer cement thickness and dentinal tubule penetration. IEJ. 2004;37:653–63.
29. Wijayanti, N. (2021). Factors related to behavior the community in disposing of garbage. International Journal of Health & Medical Sciences, 4(1), 74-79. https://doi.org/10.31295/ijhms.v4n1.1226