Review Article

Smear Layer With Different Cutting Instruments

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ABSTRACT : smear layer is invariably formed on dental tissues after it is instrumented either with hand or rotary instruments. It can be formed on the dentin surface while preparing the cavity of on the inner surface of the root dentin after instrumentation during root canal treatment. Majority of the studies have proven conclusively that it should be removed to get better results with regard to adhesion of composite resins or success of the root canal treatment. This article describes about the smear layer formed with various cutting instruments and its significance.

Key words: carbide burs, diamond burs, hand files, rotary files, smear layer

INTRODUCTION

Smear layer can be defined as the thin layer of organic and inoraganic substances formed on the dental tissues after instrumentation which may also contain microbes 1. The dental tissues when cut small chips which are microns in size block the dentinal tubules and form a thin layer. This layer is comprised of debris formed by cutting both enamel and dentin in case a cavity is prepared for the crown. The smear layer in root canal consists of debris formed by cutting dentin as enamel is not present in the root canal wall and microbes. In either of the case the inorganic content is more than organic content. The thickness ranges between 2-5um.

In Conservative dentistry cavity cutting can be done by using any of the following instruments:

1. Carbide burs
2. Diamond burs(regular grit & superfine grit)
3. Hand instruments
4. Air abrasion
5. Sono abrasion
6. Lasers

Smear layer formed when carbide burs were used, was thinner when compared to diamond burs. Also, the microtensile bond strength was more when cavity was prepared with carbide burs. Hence carbide burs were recommended when total etch multi step bonding agent is deemed to be used 2.

Coarse and superfine diamond burs each of them create a different smear layer in thickness and composition. In case of Coarse diamond burs a thick smear layer containing cut collagen fibers and hydroxyapatite crystallites is formed 3.

The smear layer formed with carbide bur is very even whereas the smear layer formed with diamond bur is rough, thick and uneven 4. More significantly, the thickness of the smear layer and the surface roughness increased with increase in the coarseness of the bur used 5.

When self etch adhesive is being used smear layer is not critical to bond strength and bonding 6.

Sono abrasion when use also results in formation of smear layer on the tooth surface. Cavities prepared with LASERS don't have smear layer. Air abrasion also produces smear layer but very thin and the surface after air abrasion is more suitable for bonding as a microretentive surface is achieved.

ENDODONTICS:

In case of chronic root canal infection like periapical abscess or necrosis of the pulp bacteria are present deep within the dentinal tubules. After instrumentation with endodontic instruments smear layer is formed. This layer is present on the dentinal surface which has been instrumented7.This layer acts as a barrier for the intracnal medicaments as they can't reach till the microbes present in the dentinal tubules and the bacteria continue to be present even after obturation which will lead to failure of the root canal treatment. Removal of the smear layer will also aid in better adaptation of the obturating material to the root canal wall and better sealing. The treatment can fail within a short duration or may take a couple of months or years depending upon the severity of infection present within the dentinal tubules. Hence it's imperative that the smear layer be removed to improve the success of the endoodntic treatment.

Another reason why smear layer should be removed from the root canal wall is when its planned to place an intracanal fibre post using adhesive resin cement. When the smear layer is removed the cement will penetrate deep within the tubules. Eventually the length of the resin tags formed will be more and the bonding will be better when compared to boding without removing the smear layer.

Two kinds of smear layer:

1. Superficial layer that is loosely attached to the dentinal walls
2. Smear material which gets packed in the dentinal tubule openings due to instrumentation. The depth to which the debris gets packed into tubules varies.

The smear layer in the initial period is rich in organic content due to presence of pulpal tissue 8, 9.

During root canal treatment smear layer can form with any of the following instruments:

Hand instruments

1. Stainless steel
2. Nickle titanium

Studies have concluded that hand instrumentation produced less smear layer when compare to rotary instruments 10, 11. Nevertheless rotary instruments were equally effective as hand instruments in removing to smear layer 12.

Rotary instruments

1. Continuous rotation files
2. Reciprocating files

Studies have proven that rotary instrumentation results in thicker smear layer compare to hand instrumentation 13. The design of the flutes also affects the formation of the smear layer. Files like HERO 642 produced less smear layer compare to profile and engine driven instruments. The depth and the frequency of materials being packed into the dentinal tubules, varied with design of the

instrument. Files with more land area produces less smear layer when compared to other files because more the land area more it can auger debris14. a variable pitch as in case of twisted files that minimizes the “screw-in” effect, allows debris to be effectively removed from the canal when compare to protaper or M2 which don't have a variable pitch15, 22, 23. When reciprocating files were used, a thicker smear layer was formed in the apical third when compare to continuous rotation files16, 17. Files produce a clean surface in the middle and coronal third but there is a smear layer in the apical third 18, 19.

OTHERS

1. Self adjusting file
2. Ultrasonic files
3. Sonic files
4. retrograde cavity preparation using diamond burs and ultrasonics

Instruments like self adjusting file produced an almost clean dentin surface free of smear layer 20. Few studies have compared ultrasonic files, sonic files and hand instrumentation and concluded that ultrasonic files produced less smear layer when compare to the other two files 21.

DISCUSSION

Smear layer has always been a topic of debate in dentistry. It has largely been proven that whether it is in restorative dentistry or endodontics it should be eliminated for a better seal and marginal adaptability. Studies have proven that most of the smear layer formed by carbide burs or diamond burs was removed after etching. 24

The smear layer harbours microbes which are a causative agent for the failure of endodontic treatment. Also, its removal improves success of endodntic treatment due to better penetration of irrigants in to the tubules within the dentin and better adapatation of the obturating material at a microscopic level. The thickness of the smear layer is 1-2um. Also, smeara layer is not present on surfaces which were not instrumented. 25

Smear layer is also formed when retrograde cavity is prepared using diamond burs or ultrasonics. The smear layer was more thicker in case of burs than with ultrasonics. 26, 27

The most effective agent to remove smear layer is 17% EDTA and 5. 25% sodium hypchlorite. Ultrasonics can also be an important aid in removing the smear layer. After the smear has been removed the dentin surface must be protected to avoid re contamination of the surface. 26, 28, 29

In adhesive dentistry, although research has proven that removal of smear layer increases the bond strength, self etching bonding agents are equally effective while retaing the smear layer. Also, few aqueous bonding agents are have good adhesion despite retaing the smear layer. Although, thick smear layers adversely affected the mean gap width. The greater pH self etching agents show better penetration of the smear layer. the concentration of acidic resin monomers and combining them with HEMA in new generation self etching bonding agents make it very effective in bonding in the presence of smear layer. 30, 31, 32, 33, 34

Conclusion: whether its restorative dentistry or endodontics it's necessary to remove the smear layer. Whichever instrument is used to prepare the cavity it should be ensured that the smear layer is removed in case the cavity is to be restored with adhesive composite restoration using total etch adhesive. In root canal although its impractical to remove all the infected dentin at least its better if the medicament reached deep within the dentinal tubules to eliminate the bacteria. This can be ensured by removing the smear layer thoroughly.

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REFERENCES

1. The smear layer in endodontics – a review D. R. Violich & N. P. Chandler, International Endodontic Journal, 43, 2–15, 2010
2. Effect of Smear Layers Created by Different Burs on Durability of Self-Etching Adhesive Bond to Dentin of Primary Teeth. Rirattanapong P, Senawongse P, Harnirattisai C, Wunsiw W. J Clin Pediatr Dent. 2015 Spring;39(3):224-30.
3. Effect of Smear Layers Created by Different Burs on Durability of Self-Etching Adhesive Bond to Dentin of Primary Teeth. Rirattanapong P, Senawongse P, Harnirattisai C, Wunsiw W. J Clin Pediatr Dent. 2015 Spring;39(3):224-30.
4. Effect of bur type and conditioning on the surface and interface of dentine, J. A. Barros, S. I . Myaki†,j. E. No¨ R & M. C. Peters, Journal of Oral Rehabilitation 2005 32; 849–856
5. The influence of the dentin smear layer on adhesion: a self-etching primer vs. a total-etch system. Oliveira SS , Pugach MK, Hilton JF, Watanabe LG, Marshall SJ, Marshall GW Jr. Dent Mater. 2003 Dec;19(8):758-67.
6. Effect of smear layers on the bonding of a self-etching primer to dentin.Tay FR1, Carvalho R, Sano H, Pashley DH. J Adhes Dent. 2000 Summer;2(2):99-116.
7. Smear layer: overview of structure and function. Pashley DH1. Proc Finn Dent Soc. 1992;88 Suppl 1:215-24.
8. Clinical implications of the smear layer in endodontics: a review.Torabinejad M1, Handysides R, Khademi AA, Bakland LK. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002 Dec;94(6):658-66.
9. The smear layer in endodontics - a review. Violich DR1, Chandler NP. Int Endod J. 2010 Jan;43(1):2-15.
10. Smear Layer Evaluation on Root Canal Preparation with Manual and Rotary Techniques using EDTA as an Irrigant: A Scanning Electron Microscopy Study. Manjunatha M , Annapurna Kini , Sudhakar V , Sunil Kumar VC , Vinay Kumar Hiremath , Ankur Shah, Journal of International Oral Health. Jan-Feb 2013; 5(1):66-78
11. Scanning Electron Microscopic Evaluation of Residual Smear Layer Following Preparation of Curved Root Canals Using Hand Instrumentation or Two Engine-Driven Systems Abbasali Khademi, Masoud Saatchi , Mohammad Mehdi Shokouhi, Badri Baghaei, Iranian Endodontic Journal 2015;10(4): 236-239
12. Effectiveness of Rotary Endodontic Instruments on Smear Layer Removal in Root Canals of Primary Teeth: A Scanning Electron Microscopy Study. , Girish Babu KL, Tabrez TA. J Clin Pediatr Dent. 2016;40(2):141-6.
13. Mechanical root canal preparation with NiTi rotary instruments: rationale, performance and safety. Statusreport for the American Journal of Dentistry.Bergmans L1, Van Cleynenbreugel J, Wevers M, Lambrechts P. Am J

Dent. 2001 Oct;14(5):324-33.

14. Smear layer production by 3 rotary reamers with different cutting blade designs in straight root canals: a scanning electron microscopic study. Jeon IS1, , Yoon TC, , Kum KY. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003 Nov;96(5):601-7.

15. 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, Gaurav Sharma , Pooja Kakkar , Asit Vats, Journal of Clinical and Diagnostic Research. 2015 Mar, Vol-9(3)

16. Smear layer removal in canals shaped with reciprocating rotary systems Paula Amaral, Leopoldo Forner, Carmen Llena, J Clin Exp Dent. 2013;5(5):e227-30.

17. Effects of NiTi rotary and reciprocating instruments on debris and smear layer scores: An SEM evaluation, Claudio Poggio, Alberto Dagna, Marco Chiesa, Andrea Scribante, Riccardo Beltrami, Marco Colombo, J Appl Biomater Funct Mater. 2014 Dec 30;12(3):256-62.

18. SEM evaluation of canal wall dentine following use of Mtwo and ProTaper NiTi rotary instruments. Foschi F1, Nucci C, Montebugnoli L, Marchionni S, Breschi L, Malagnino VA, Prati C.Int Endod J. 2004 Dec;37(12):832-9.

19. Scanning Electron Microscopic Evaluation of Root Canal Surfaces Prepared with LightSpeed & Endowave rotary system, Hema.B.S1, G.S Chandu2, Vijayakumar L Shiraguppi, Journal of Clinical and Diagnostic Research. 2014 Dec, Vol-8(12)

20. The self-adjusting file (SAF). Part 3: removal of debris and smear layer-A scanning electron microscope study. Metzger Z1, Teperovich E, Cohen R, Zary R, Paqué F, Hülsmann M. J Endod. 2010 Apr;36(4):697-702.

21. Manual sonic-air and ultrasonic instrumentation of root canal and irrigation with 5.25% sodium hypochlorite and 17% Ethylenediaminetetraacetic acid: A scanning electron microscope study. Ferit Koçani, Blerim Kamberi, and Edmond Dragusha. J Conserv Dent. 2012 Apr; 15(2):118-22.

22. Claudio Poggio, Alberto Dagna, Marco Chiesa, Riccardo Beltrami, Marco Colombo , Ultrastructural analysis of the root canal walls after preparation with two rotary nickel-titanium endodontic instruments , Contemporary Clinical Dentistry,Jul-Sep2014,Vol5,Issue3 .

23. S. Soumya, Shalini Aggarwal, Anamika Borkar, Anita Tandale, Pradeep Shetty, Swapnil Bhosale , A scanning electron microscopic study of smear layer remaining following use of Greater Taper rotary instruments , Journal of the International Clinical Dental Research Organization | January-April 2011 | Vol 3 | Issue

24. Sudhir Sherawat 1 , Sanjay Tewari 2 , Jigyasa Duhan 3, Alpa Gupta 4, Rakesh Singla, Effect of rotary cutting instruments on the resin-tooth interfacial ultra structure: An in vivo study, J Clin Exp Dent. 2014;6(5):e467-73.

25. Shishir Shetty, Sureshchandra B, An SEM evalution of the type of smear layer produced by newer rotary instruments and effectiveness of different combinations of irrigants, Endodontology, Vol 21 Issue 2, December 2009, 53-66

26. Sen BH1, Wesselink PR, Türkün M. The smear layer: a phenomenon in root canal therapy. Int Endod J. 1995 May;28(3):141-8.

27. J. L. Gutmann*, w. P. Saunders ^ I. Nguyen*, i. Y. Guo* & e. M. Saunders, Ultrasonic root-end preparation Part 1. SEM analysis, Intemational Endodontic Journal il994:) 27. 318-32.

28. von Arx T, Walker WA. Microsurgical instruments for root-end cavity preparation following apicoectomy: a literature review. Endod Dent Traumatol 2000; 16: 47–62.

29. Torabinejad M1, Handysides R, Khademi AA, Bakland LK. Clinical implications of the smear layer in endodontics: a review. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002 Dec;94(6):658-66.

30. Czonstkowsky M1, Wilson EG, Holstein FA. The smear layer in endodontics. Dent Clin North Am. 1990 Jan;34(1):13-25.

31. Hayakawa T1, Nemoto K, Horie K. Adhesion of composite to polished dentin retaining its smear layer. Dent Mater. 1995 May;11(3):218-22.

32. Kenshima S1, Reis A, Uceda-Gomez N, Tancredo Lde L, Filho LE, Nogueira FN, Loguercio AD. Effect of smear layer thickness and pH of self-etching adhesive systems on the bond strength and gap formation to dentin. J Adhes Dent. 2005 Summer;7(2):117-26.

33. Reis A1, Grandi V, Carlotto L, Bortoli G, Patzlaff R, Rodrigues Accorinte Mde L, Dourado Loguercio A. Effect of smear layer thickness and acidity of self-etching solutions on early and long-term bond strength to dentin. J Dent. 2005 Aug;33(7):549-59.

34. Alessandra Reisa,*, Viviane Grandia , Larissa Carlottoa , Giana Bortolia , Rafael Patzlaffa , Maria de Lourdes Rodrigues Accorinteb , Alessandro Dourado Loguercio, Effect of smear layer thickness and acidity of self-etching solutions on early and long-term bond strength to dentin, Journal of Dentistry (2005) 33, 549–559

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