

Comparative Evaluation on Effects of Diamond Burs and Smart Burs on Smear Layer Removal: A SEM Study

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ABSTRACT

Aim: Compare and evaluate effects on smear layer using various burs.

Material and Methods: 40 extracted teeth with proximal caries were selected for the study. Caries was removed using either diamond burs and smart burs (SS white). Smear layer was evaluated using Scanning electron microscope.

Results: Diamond burs removed more smear layer than smart bur. However, it was statistically non-significant. However, time taken for caries removal was significantly more for smart burs than diamond burs.

Conclusion: Although time taken by smart burs was more, it still could be an effective ultraconservative hassel free alternative method for caries removal.

Keywords: Dental caries, smear layer, smart burs, Scanning electron microscope.

INTRODUCTION

Change is an obligation, an inevitable weapon for the countless challenges the future holds. Such is the change slowly emerging in the field of dentistry too. Dental caries has been the most devious ailment faced by humanity. It has to be removed at the earliest to avoid further destruction of the tooth structure which may eventually lead to extraction. Hence eliminating the carious lesion at a level when the tooth is still restorable is necessary for prevention of destruction of the tooth. A successful elimination of caries removal would be framed as one with a durable restoration and no post treatment sensitivity. However one often neglected factor in the success of caries removal is the smear layer which was recognized and named by Boyde et al in 1963. Smear layer is a layer of grinding debris consisting of of shattered hydroxyapatite crystals, denatured collagen, blood, saliva and

microorganisms found on the prepared tooth surface when caries is removed either by hand or rotary instruments.¹

There is still a lot of controversy in the literature regarding the advantages and disadvantages of keeping a smear layer prior to restoration. Some have suggested that it is unfavourable to retain this layer as it may be contaminated by microorganisms. White et al (1984) stated that in clinical conditions, if present, this layer may be contaminated by bacteria and saliva. Another disadvantage of a smear layer covering the bonding surface is its inherently weak bond to the underlying dentin as claimed by Pashley et al(1992). However, advantages of keeping this layer were also reported. Pashley et al (1992) stated that removal of this layer increases the permeability of the dentinal tubules radically thereby permitting fluid flow from outside the pulp chamber and vice versa. And as the

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main mechanism of tooth sensitivity is based on hydrodynamic fluid movement, removal of smear layer may cause tooth sensitivity.¹ Bhagwat et al (2016) stated that the presently accepted concept is to remove the superficial smear layer while retaining or modifying the smear plugs.²

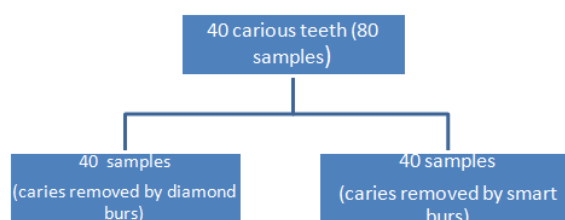
Various instruments are available for removing carious lesion. With its introduction in 1939, diamond burs have been the most widely used bur for carious removal. But along with being a very efficient caries removal rotary instrument, it also leads to unnecessary removal of healthy dentin which may further cause sensitivity due to open dentinal tubules.

Thus a novel, self-limiting, bur was introduced in 2001 named smart burs (Smart Prep, SS White Burs, Inc., Lakewood, NJ, USA).³ This paddle-shaped bur has a unique flute design, and is constructed from a medical-grade polyether-ketone- ketone, with a hardness comparable to that of carious tooth and not the sound tooth structure and wear resistance that reportedly enables it to remove only the soft caries-infected dentin, leaving the caries-affected dentin intact.⁴ Thus eventually leads to conservation of sound tooth structure.

Keeping this in mind, the aim of the present study was to comparatively evaluate the effect on smear layer using various burs i.e diamond burs and smart burs (SS white) using scanning electron microscope. The time factor for caries removal was also evaluated.

MATERIAL AND METHOD

Forty extracted teeth with proximal caries were selected for the study. The samples were autoclaved and cleaned using ultrasonic scaler to remove the debris and then stored In saline to avoid dehydration. The samples were then sectioned by using a rotating diamond disk in micromotor into buccal and lingual halves. Each section was further split at the Cementoenamel junction giving off two parts i.e the coronal and the radicular part. Only the coronal part of each section with caries was taken. The total eighty samples thus obtained were randomly divided into two groups.



Flowchart 1: Division of samples

In group A, caries was removed using diamond burs in micromotor while in group B caries was removed using smart burs in micromotor. Completion of caries removal was checked using Erickson's criteria i.e.{optical (colour) and tactile (hardness)}. The time taken for caries removal for each technique was measured using a stopwatch. After caries removal, the samples were evaluated for smear layer removal using scanning electron microscope.

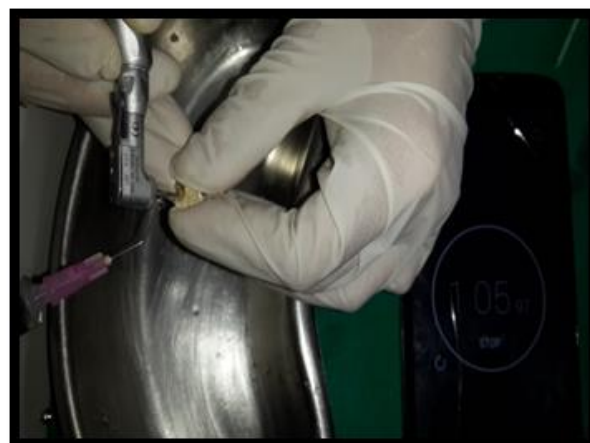


Fig 1: Caries removed by diamond bur.



Fig 2: Caries removed by smart bur.

Preparation of samples for scanning electron microscope

The samples were mounted on stubs using a double-stick adhesive. The stubs are then placed in the sputter coater's chamber for 160 seconds for palladium sputtering. The samples were then transferred to the scanning electron microscope for image analysis. Thereafter, the removal of smear layer was checked and evaluated.

Scoring of smear layer removal

The smear layer removal was scored using the following criteria ^{5,6}

Score 1: absence of smear layer

Score 2: moderate smear layer

Score 3: dense smear layer with visible dentinal tubules

Score 4: dense smear layer with no visible tubules

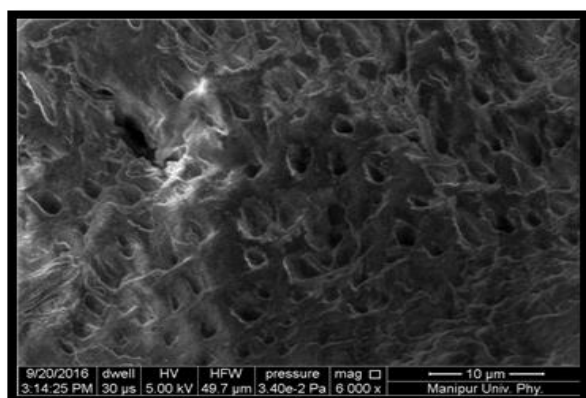


Fig 3: Score 1 = absence of smear layer.

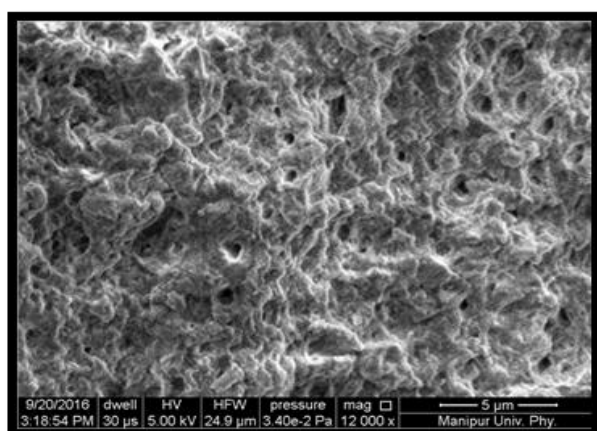


Fig 4: Score 2 = moderate smear layer.

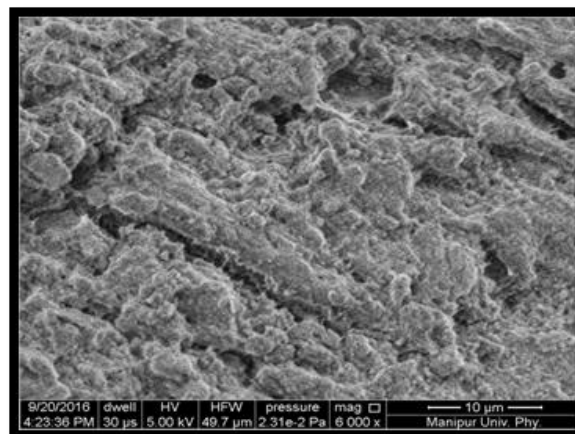


Fig 5: Score 3 = dense smear layer with visible dentinal tubules.

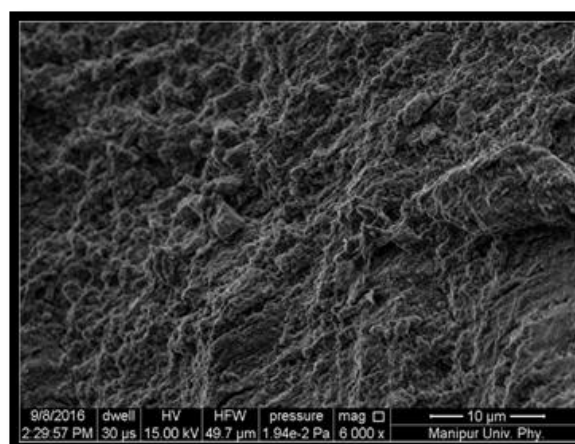


Fig 6: Score 4 = dense smear layer with no visible tubules.

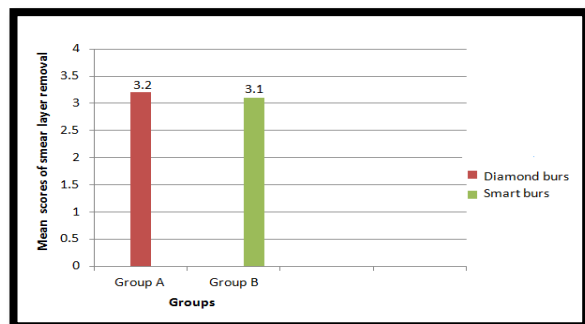
Data was collected, tabulated and statistically analyzed using Mann Whitney test

RESULTS

The mean scores of smear layer removal using diamond burs was found to be 3.2 ± 0.724 while the mean score of smear layer removal by smart burs (group B) was 3.1 ± 0.663 (table 1). After intergroup comparison was done between group A and group B using Mann Whitney test(or U test), the results were statistically non significant with p value at 1.6.(graph 1)

Table 1: mean values of smear layer removal in group A and group B.

Group	N	Mean	Standard deviation	Mean rank	Mann whitney U	P value
Group A (Conventional burs)	40	3.2	0.2	40.50	188.0	1.6
Group B (Smart burs)	40	3.1	0.28	40.80		

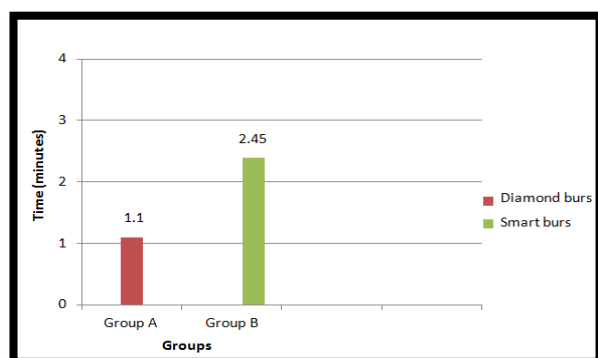


Graph 1: Mean values of smear layer removal in Group A and Group B

The mean value of time taken for caries removal by diamond burs (group A) was 1.1 ± 1.19 while the mean value of time taken for caries removal by smart burs (group B) was 2.45 ± 2.12 (table 2). After intergroup comparison was done between group A and group B using Mann Whitney test (or U test), the results were statistically significant with p value at 0.01. (graph 2)

Table 3: mean values of time taken for caries removal in group A and group B.

Groups	N	Mean (mins)	Standard deviation	Mean rank	Mann whitney U	P value*
Group A (Conventional burs)	40	1.1	0.48	2.4	2.00	0.01
Group B (Smart burs)	40	2.45	23.2	1.6		



Graph 2: Mean of time taken for caries removal in both groups.

DISCUSSION

The removal or retention of smear layer has been constantly debated over time. Whether this layer should be removed or retained has not been established but there has been various studies with varied conclusions. Some claim this layer should be removed as it harbours microorganisms and it acts as a barrier against establishing a good bond for restorations while others reported that complete removal of this layer lead to hypersensitivity due to the open dentinal tubules. This saga of debate over retention or removal of the smear layer has been inconclusive. But recently with the advent of smear layer incorporating bonding systems, there has been a slight bend of opinion towards retention rather than complete removal of this layer.

Thus presently recommended concept about smear layer is to remove it to an extent to enhance bonding of restorative material while retaining some amount on the prepared tooth surface to avoid exposure of healthy dentinal tubules. Keeping this in mind the present study was undertaken.

On assessing the smear layer removal after using conventional and smart burs, it was found that the mean score of smear layer removal was 3.2 for conventional burs and 3.1 for smart burs. But when intergroup comparison was done of the mean smear layer removal when caries was removed using conventional burs and smart burs it was found to be statistically non significant (p value=1.6). Smear layer is present on the prepared tooth surface and is reported to be loosely bound to the underlying surface as it mainly comprises of shattered hydroxyapatite, denatured collagen, saliva, blood and microorganisms. In the present study, diamond burs produced more smear layer because diamond burs are made of stainless steel core on which diamond chips are attached, having greater hardness of 7000 KHN due to which it has greater cutting efficiency without applying more pressure. As more loosely bound smear layer is produced it gets removed also in a comparatively larger amount by the flushing action of the irrigating solutions which were used during the entire process of caries removal. Whereas smart burs are made of polyether ketone ketone which has a hardness of just 50 KHN due to which more pressure was applied while removing carious lesion. Thus, the smear layer

might have got stuck to the prepared cavity walls forcing more amount into the dentinal tubules leading to availability of lesser amount of loosely bound smear layer. Thus comparatively lesser amount of smear layer is removed by the flushing action of the irrigating solution. Peycheva K et al, 2013 concluded in his study that working with Smart Burs (SSWhite) leads to denser and compact smear layer which was thus more difficult to remove burs. Trivedi P, 2014 also stated in their study that diamond burs produced a thicker smear layer than carbide burs.^{7,8}

The efficacy of both the method in terms of time taken for caries removal was evaluated by using stopwatch in the present study. The time required for removal of caries with smart bur removal method took an average of 2.45 minutes as compared to diamond bur which took only 1.1 minutes. But after intergroup comparison there was a statistically significant difference between both the groups (p value=0.01). The possible reason would be because of higher hardness number (7000KHN) and higher cutting efficiency of diamond burs. Thus the process of removing carious lesion is done in a much lesser time. However Smart burs has a low cutting efficiency which in turn slows down the process of carious removal because it has a hardness of just 50KHN as it is made of polyether ketone ketone.^{9,10} Moreover it's cutting surface comprises of paddle shaped flutes with blunt ends and are lesser in number. An in-vivo study conducted by Attiguppe P (2009) also supported more time consumption in caries removal by smart burs compared to conventional burs.¹¹

Smart burs preserve healthy dentin and from the results in the present study, it was found to have comparable effect on smear layer removal with diamond burs. Thus smart burs could be a better, ultrastructurally conservative method of caries excavation preventing over preparation of carious surface although with a minor setback of taking more time than diamond burs.

CONCLUSION

Therefore, in the present study it can be concluded that the smear layer removed by smart burs in cavitated teeth was comparable to that of diamond burs. Although time taken by smart burs was more,

it still could be an effective ultraconservative hassel free alternative method for caries removal. We recommend further studies to authenticate these results.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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