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ORIGINAL RESEARCH

Effect of Different Burs on the Topography of Smear Layer Formation on the Dentinal Surface: A Scanning Electron Microscope Study

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ABSTRACT

Whenever a hand or a rotary instrument is used to eliminate tooth tissue, the mineralized matrix shatters rather then being uniformly sheared, producing considerably quantities of cutting debris. Much of the debris made up of very small particles of mineralized collagen matrix over the surface of dentin is known as smear layer. The clinical outcome of dental restorations is dependent upon the surface preparations, smear layer formation and hybrid layer which which provides a stable adhesion. Different surface morphology is produced by use of different burs. The thickness of the smear layer is affected by various factors as type of the bur, use of water spray and speed of rotation. Bonding is enhanced when smear layer is completely removed or modified. The purpose of this *in vitro* study is to evaluate the effect of different burs on the topography of the smear layer formation and thickness on dentinal surface.

Keywords: Burs, Smear layer, SEM, Debris

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INTRODUCTION

As truly said: 'Necessity is the mother of invention' Although archeological evidence of dental treatment dates from as early as 5000 BC, little is known about the equipment and methods used then. Much of the development occurred with the hand cutting instruments followed by the revolution with the introduction of the present rotary cutting instruments along with the introduction of burs, and cutting of the dental tissues rapidly improved. Whenever, a tooth tissue is abraded either with hand or rotary instruments, collection of debris on the cut tooth surface is evident.[1] The layer created is recognized as 'Smear Layer'.

Unknown and unrecognized for years, the smear layer has become a force to be reckoned with during the last decade. Most of the dentists now know it exists, but are often puzzled as to whether or not they should cope with it. Since the smear layer has been recognized, the dentist has come to realize that they must get re-acquainted with the science of dental materials so that they can understand the relationships of the products they work with to the smear layer.[2]

Early attempts to define the cut surface of tooth structure were limited principally to light microscopy (1952). The nature of the cut surface of the tooth structure, as observed by electron microscopy was described by Scott and O'Neil, 1961. It was not until the advent of scanning electron microscopy that the grinding debris was first referred to as 'Smear Layer' by Boyde, Switsur and Stewart (1963).[3] As suggested by David Pashley, the smear layer as a cavity liner may unquestionably have both beneficial and detrimental effects. There is a need to alter the traditional procedures to take advantage of the former and avoid the later.[4] Some phases of cosmetic dentistry demand that, depending on what type of dentin bonding agent is used, the smear layer to be retained, and other materials dictate its removal or modification.[6]

Thus, the purpose of this study is to investigate the surface morphology or topography of dentin cut by different rotary instruments (burs-coarse, medium, fine grit, finishing bur and tungsten carbide cutting bur) on the smear layer formation.

MATERIALS AND METHODS

In the current study, 60 freshly extracted human upper central incisors were selected. The teeth were cleaned of any calculus, stains, soft tissue and other debris by ultrasonic scaling and disinfected in hydrogen peroxide. The teeth were stored in distilled water.

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Inclusion criteria: Intact single rooted upper central incisors with intact crown.

Exclusion criteria: Carious teeth, Abraded teeth, Attrited teeth, Stains.

All the teeth were mounted in the blocks made up of modeling wax. They were then divided into 6 groups each and 10 teeth in each group. Group I – Dentin surfaces prepared with Silicon carbide paper 600 grit, group II – Dentin surfaces prepared with coarse diamond bur, group III – Dentin surfaces prepared with medium grit diamond bur, group IV – Dentin surfaces prepared with fine grit diamond bur, group V – Dentin surfaces prepared with finishing bur, group VI – Dentin surfaces prepared with tungsten carbide cutting bur (6-fluted).

The labial surface of the central incisors were grinded until the superficial dentin was exposed, using a high-speed handpiece with copious water spray. Dentin surface of each tooth was prepared giving 30 strokes with gentle pressure in one direction only. The teeth were then sent for scanning electron microscope study to evaluate the smear layer formation by each bur.

SEM ANALYSIS

SEM analysis was performed at the Plasma Research Laboratory, Ahmedabad, Gujarat. Scanning electron microscope (SEM) works on the principle of TV and resembles television method.

RESULTS

Statistical analysis: Data was presented as numbers with the presence or absence of surface distortions. SPSS software (Version 9.0) was used for the statistical analysis.

Mean and standard deviations were found to know the type and amount of surface distortion values. One way ANOVA test was done to find out the significant results.

For all the tests a p value of 0.05 or less was considered for statistical significance.

DISCUSSION

The earliest studies on the effect of various instruments on dental tissues were those reported by Lammie Draycott (1925) and Street (1953). After the use of the different abrasive stones and burs, these authors using powdered graphite, disclosed ridges and troughs on the cut surfaces. When viewed with light microscopy and illumination, the pattern and magnitude of the grooves varied with diamond abrasives producing the most striking anamoly.[6]

Sections or Shadowing Techniques[3]

The term smear layer is most often used to describe the grinding debris left on dentin surface by cavity preparation. The term bur is applied to rotary cutting instruments that have cutting heads. Diamond and carbide burs are most commonly used for cavity cutting. Carbide burs are better for cutting as they produce lower heat and have more blade edges. Diamond rotary instruments have higher hardness and excellent cutting effectiveness.[26]

The formation and treatment of the smear layer is a matter of interest for bonding procedures in order to obtain an effective bonding to dentin.[29] Smear layer is created whenever a hand or rotary instrument is used to eliminate or cut tooth tissue. The debris produced by instrumentation covers the dentin surface and obliterates the dentinal tubules.[28]

In the present study, six groups were taken out of which group I was instrumented with SiC 600 grit paper, which under SEM analysis was found to have thinnest smear layer with almost minimal rough and irregular surface (Fig. 1). This finding is in concurrence with that of Franklin et al, (2000), who stated that smear layer produced by 600 grit SiC paper was thinnest and relatively smoother as compared to coarse grit, medium grit diamond burs and tungsten carbide burs.[21] Under SEM analysis, group II, which was instrumented with coarse diamond bur (125 μ grain size), produced the thickest smear layer (2.4 μ) with irregular and more undulating surface (Fig. 2). This finding is consistent with that of Ayad (1996) who stated that coarse diamond burs created a thick and a compact smear layer with irregular and undulating surface when compared with medium, fine and superfine grit diamond burs.[18]

Group III which was instrumented with medium grit diamond bur (100 μm grain size) created a moderately thick smear layer (Fig. 3) (2.2 μm) with less irregular surface as compared to coarse diamond burs. These results are consistent with the study done by Ogata et al (2002) who concluded that thickness of the smear layer increased with the coarseness of the bur. Under SEM observation, group IV in which dentin surfaces were prepared with fine grit diamond bur (Fig. 4) (30 μm grain size) produces a thin smear layer (1.2 μm) with more smooth and less irregular surface than coarse and medium grit diamond burs. In current study, when compared with tungsten carbide burs the smear layer thickness resembled each other. This findings are consistent with the study done by Kaori et al (2004) and stated that fine grit diamond bur created a thin smear layer and less irregular surface as compared to coarse and medium grit diamond burs.[27]

Under SEM analysis, group V which was instrumented with superfine grit diamond bur (finishing bur) 15 μm grain size produced thin smear layer (1 μm) with smooth surface (Fig. 5). In the current study, smear layer thickness of super-fine grit diamond finishing bur resembles with SiC 600 grit paper with no significant difference. This findings are consistent with the study done by Inoue et al (2001) and

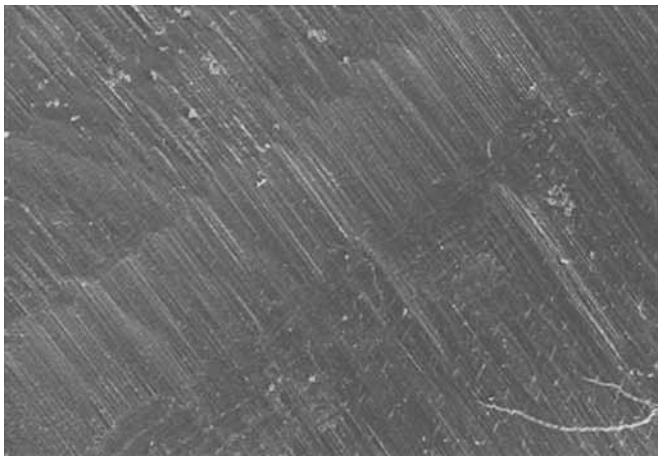


Fig. 1: Smear layer formation with SiC grit paper (500×)

Fig. 2: Smear layer formation with coarse grit bur (500×)

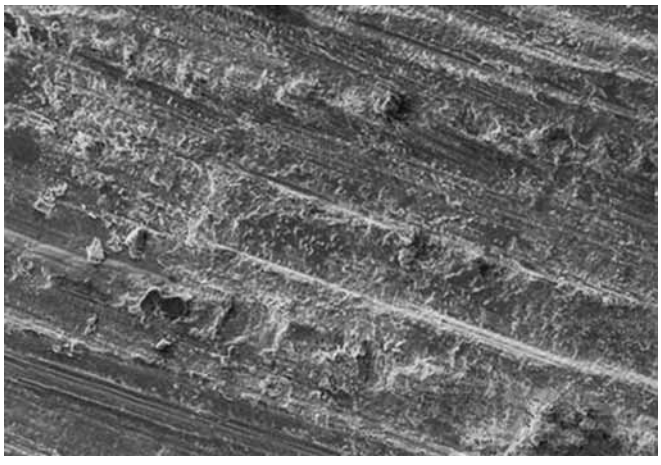


Fig. 3: Smear layer formation with medium grit bur (500×)

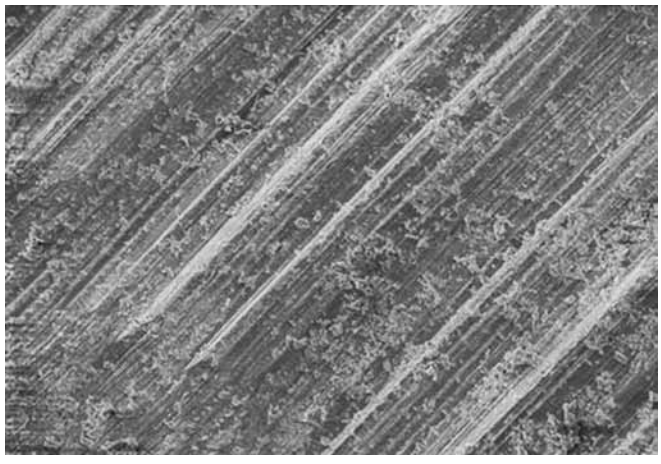


Fig. 4: Smear layer formation with fine grit bur (500×)

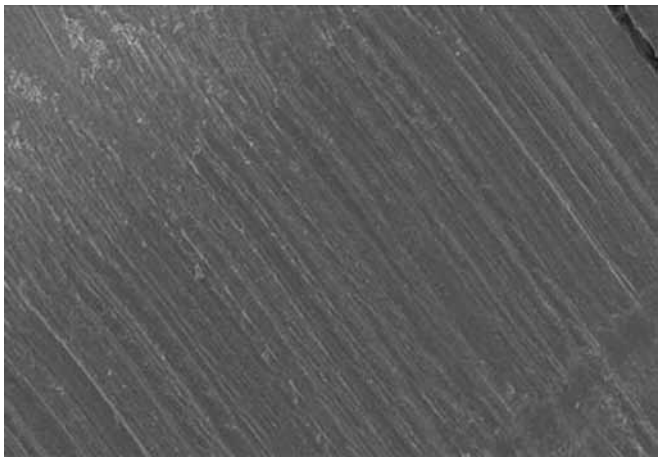


Fig. 5: Smear layer formation with super-fine grit bur (500×)

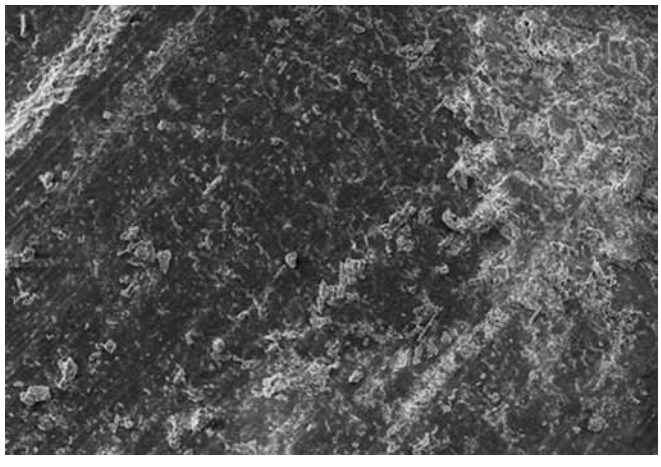
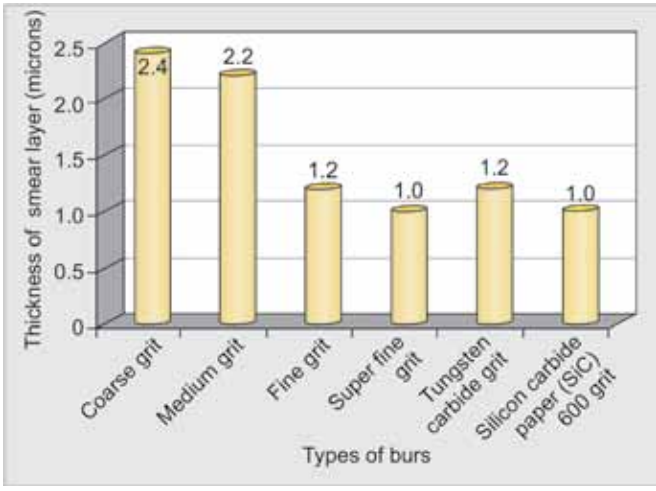


Fig. 6: Smear layer formation with tungsten carbide bur (500×)

concluded that tooth surfaces grinded with medium and fine grit diamond bur created a thick smear layer as compared to super-fine grit diamond bur. Under SEM analysis, group VI which was instrumented with tungsten carbide bur (6 fluted) produced a thin and irregular smear layer with particles occluding the dentinal tubules and also showed narrow grooves on the cut surface (Fig. 6). In the present study, smear layer produced by tungsten carbide bur and fine grit diamond bur showed no significant difference. This findings are consistent with the study done by Barros et al (2005) and stated that surface prepared with coarse, medium and fine grit diamond burs produced a thick and a compact smear layer than carbide burs.[28]

CONCLUSION

A layer of sludge material is always formed when any tooth tissue is instrumented which is known as smear layer. Such layers exist irrespective of the type of the cutting instrument or the manner in which it is used. The quality and quantity of the smear layer is influenced by the operating conditions



Graph 1: Comparison of Smear layer thickness between different types of rotary burs

like type of the instrument used, dry or wet cutting of the substrate and speed.

Based on the present study, it can be concluded that coarse diamond burs produce a thickest smear layer when compared with other grits and tungsten carbide bur. Thinnest smear layer is produced by silicon grit paper and superfine grit bur. Thus, the present study concluded that smear layer thickness increases with the increased thickness or coarseness of the bur or abrasive (Graph 1).

Therefore, with the cascade of new restorative products being unveiled, dentists must be able to evaluate the potential of these products for successful integration into their procedures. However, the total understanding of the significance smear layer is far from complete whether it should be removed or not, still remains controversial and thus it necessitates further research.

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