Comparison Of Dentin Caries Excavation With Polymer Bur, Diamond Bur And Conventional Tungsten Carbide Burs - An In Vivo Study

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Abstract
To compare the effectiveness of polymer burs (Smart Prep, SS White) and conventional carbide & diamond burs in removing dentin caries.

Method and Materials: Fifteen patients with carious permanent teeth were assigned to 3 groups according to the caries removal technique. Green staining by the dye indicates caries, whereas no staining indicates exposed inner dentin or normal dentin. Using the dye as a guide, sequential thin layers are removed with burs until the excavated surface is no longer stained. Tactile and visual judgments have been used to evaluate whether infected dentin was removed after cavity preparation.

Result: No significant differences were observed in the mean dentin caries removal with diamond and carbide bur. The mean values for the carious surface areas differed minimally between polymer bur with carbide and diamond bur.

Key Words
Polymer Bur, Carbide Bur, Diamond Bur, Caries Revealing Dye.

Introduction
The techniques used in carious dentine removal have developed since GV Black, in 1893, initially proposed the principle of 'extension for prevention' in the operative treatment of carious lesions. He proposed that the removal of sound tooth structure and anatomical form at sites that might otherwise encourage plaque stagnation (eg occlusal fissures, approximal contact points) would help minimise caries onset and progression. These principles of cavity preparation were based on the clinical presentation of caries and constrained by the knowledge of the disease process and the restorative materials available at that time.

A number of excavation techniques are available to the dentist. It has been suggested that during the operative treatment of carious dentine, only the heavily infected, softened and wet dentine require removal prior to restoration placement. The outer layer of carious dentin, which is 1 of the 2 distinct carious layers, is highly infected with bacteria, and collagen fibrils are irreversibly denatured. The inner caries-affected layer, invaded by fewer bacteria, has limited collagen denaturation and is capable of remineralisation. Thus the goal is to preserve the potentially remineralizable inner layer as much as possible.

When removing demineralized dentin, it is not always easy to know when to stop excavation because there is an apparent lack of objective clinical markers. Traditionally, tactile and visual judgments have been used to evaluate whether infected dentin was removed after cavity preparation. The introduction of caries detector dyes for clinical use can be a means to overcome the inherent problem of classical visual and tactile techniques to ensure acceptable clinical excavation without persisting bacteria. Staining by the dye indicates caries, whereas non-staining indicates exposed inner carious dentin or normal dentin. Using the dye as a guide, sequential thin layers are removed with burs until the excavated surface is no longer stained. A disadvantage of the technique is that non-carious dentin may be stained.

Traditionally, carious dentin may be removed mechanically with burs, hand excavators, and air-abrasion. Since diamond and tungsten carbide burs are indiscriminate in their removal of carious tissues, they can remove caries-infected and caries-affected dentin simultaneously, with possible extension into the underlying sound dentin. This may be accompanied by pain and necessitates the application of local analgesia during treatment. A novel, recently proposed, self-limiting concept in mechanical caries removal has been brought to fruition by the introduction of a polymer bur (Smart Prep, SS White Burs, Inc., Lakewood, NJ, USA). The paddle-shaped bur has a unique flute design, and is constructed from a medical-grade polyether-ketone-ketone, with a particular hardness and wear resistance that reportedly enable it to remove only the soft caries-infected dentin, leaving the caries-affected dentin intact. Utilized exclusively at low speed (500-800 rpm), the bur quickly dulls and vibrates when it encounters the more highly calcified caries-affected dentin. Although the self-limiting concept of caries removal appears to have potential
merits, and its use without local anesthetic is accepted by patients, the ability of the polymer bur to remove infectious carious tissues and produce optimal bonding substrates in the remaining dentin has not been established.\textsuperscript{(16)}

The Objective of this study is to compare the effectiveness of polymer burs (Smart Prep, SS White) and conventional carbide & diamond burs in removing dentin caries with the help of Tactile sensation, visual appearance, acoustic characteristics (a sharp scratching sound), and/or caries detector dyes.

\textbf{M\textit{ati}eres and \textit{M\textit{et}h\textit{od}}}

This study was conducted in Department of Conservative and Endodontics, Bhojia Dental College and Hospital, Baddi, (H.P)

\begin{itemize}
  \item Polymer burs (no.4, Smart Prep, SS White)
  \item Round carbide bur (no. 4, SS White Co)
  \item Round diamond burs (BR 41, SS White Co)
  \item Sterile spoon excavator.
  \item LA (LIGNOCAD ADR, CADILA phrm.)
  \item Air Rotor (NSK)
  \item Suction tip
  \item Micro motor and contra angle (Marathon, NSK JAPAN)
  \item Caries Revealing dye (PREVEST DENPRO LIMITED)
\end{itemize}

\textbf{M\textit{et}h\textit{od}}

Fifteen patient who attended as outpatients in the Department of conservative and endodontics, Bhojia dental college Baddi, Himachal, India, were selected. All teeth with occlusal dentinal carious lesions without pulpal involvement were chosen. Caries diagnosis was done both clinically and radiographically using intraoral periapical radiograph (IOPA) in addition to visual and tactile assessment to judge the depth of the teeth’s carious lesions. Ethical clearance was obtained from the institution’s research ethics committee, Bhojia dental college Baddi, Himachal, India and each patient was signed an informed consent form.

The criteria for inclusion in the sample stipulated that each patient must have occlusal carious lesions on with softened dentin involvement.

The exclusion criteria were: Teeth following clinical or radiological signs and symptoms: pulpal, periodontal, and soft tissue pathology in the involved tooth. Also excluded were nonvital teeth and teeth with pit and fissure caries.

Caries excavation was done by a single operator in all teeth, which were divided into 3 groups. All teeth in each group were isolated with a rubber dam, and surface debris and the outermost layer of carious dentin were removed using a sterile excavator. Cavities were rinsed with saline and dried with a sterile cotton pellet. If there is any hard enamel covering the soft caries was removed by air-Rotor.

Group-1: Carbide Bur (n=5), caries was excavated using a new round carbide bur (no. 4, SS White Co) with a slow-speed handpiece at 800 rpm from the occlusal aspect until hard dentin was detected using straight probe. Caries removal was verified with a dental explorer and then with the caries detector dye (PREVEST DENPRO LIMITED), as recommended by the manufacturer. The caries detector dye was dropped onto a sterile cotton pellet, and then the pellet was placed into the cavity and removed after 10 seconds. The solution was rinsed off with sterile saline. When small areas of carious dentin were observed with the help of the dye, caries removal was again carried out.

For Group 2-Smartburs (n=5): New polymer burs (Smart bur, nos. 4, SS White Co) were used with slow speed handpiece at 800 rpm. Caries was excavated with circular movements starting from the center of the lesion to the periphery, as recommended by the manufacturer. Caries removal was verified with a dental explorer and then with the caries detector dyes (PREVEST DENPRO LIMITED), as recommended by the manufacturer. The caries detector dye was dropped onto a sterile cotton pellet, and then the pellet was placed into the cavity and removed after 10 seconds. The solution was rinsed off with sterile saline. When small areas of carious dentin were observed at the undercut with the help of the dye, caries removal was again carried out.

Excavation was stopped when the instrument became macroscopically abraded and blunted and was no longer able to remove tissue.

For group 3-diamond bur 3 (n=5) Caries was excavated using a new round diamond bur (no. BR 41, SS White Co) with a slow-speed handpiece at 800 rpm from the occlusal aspect until hard dentin was detected using straight probe. Caries removal was verified with a dental explorer and then with the caries detector dye (PREVEST DENPRO LIMITED), as recommended by the manufacturer. The caries detector dye was dropped onto a sterile cotton pellet, and then the pellet was placed into the cavity and removed after 10 seconds. The solution was rinsed off with sterile saline. When small areas of carious dentin were observed with the help of the dye, caries removal was again carried out.

\textbf{R\textit{esu}\textit{ls}}

No significant differences were observed in the dentin caries removal with diamond and carbide bur. The carious surface areas differed minimally between polymer bur with carbide and diamond bur. As the caries removal was verified with a dental explorer and then with the caries detector dye was found that small amount of discouloured surface was left in case of polymer bur used but in diamond and carbide group all the discouloured surfaces was removed. (Fig 1, 2, 3)

\textbf{D\textit{iscu}\textit{sion}}

Dentin caries removal is normally accomplished using rotary carbide burs and hand excavators. Carbide burs, which perform better than steel burs, are superior at a higher speed but mostly are associated with noise, pain, overheating, vibration, and discomfort.\textsuperscript{(31)} Recently, special burs made of polymer material were introduced and the hardness of this bur is less than that of healthy dentin but more than infected dentin.\textsuperscript{(32)}

After caries removal under in vitro study conditions, a slightly but clinically irrelevant greater amount of residual caries was found using the polymer burs compared to that obtained with carbide burs and diamond bur. The method can apparently differentiate between soft and hard tissue, but, as conventional carbide and diamond burs do, polymer burs may not be able to differentiate softened but still reminerizable hard tissue with minimal collagen degradation.\textsuperscript{(33)}

In a recent in vitro study, Celiberti et al.\textsuperscript{(44)} assessed the speed and caries removal effectiveness of 4 different dentin
excavation methods in primary molars. The procedure of determining the dentin hardness during caries removal with an explorer is seen clinically as a good standard prerequisite for future treatment success.

Kidd et al.\(^1\) found significantly less cariogenic bacteria in hard dentin than in softened dentin. However, clinical hardness does not necessarily correspond with the amount of carious dentin that should strictly be removed. The distinction must be made between infected carious dentin, which should always be removed, and affected carious dentin, which may be left. Intact collagen forming the demineralized, slightly softened inner dentin layer of a caries lesion can be remineralized, i.e., hardened,\(^1\) and therefore, from a biologic and therapeutic point of view, must not necessarily be eliminated.

Several studies also showed that caries detector dyes cannot discriminate affected, non-infected, sclerotic (translucent), or reparative dentin.\(^1\)\(^,\)\(^5\)\(^,\)\(^9\) These facts have to be considered in studies like the present one that use caries-detector dyes, because the results may lead to an overestimation of the real amount of affected carious dentin tissue that must be eliminated. Thus, the minimal amount of residual caries found for method using burs could be considered clinically irrelevant, but the exact contribution of each of these factors needs to be clarified in future studies.

**Conclusion**

Under the presented in vivo study conditions, diamond and tungsten carbide burs were similarly effective for stained dentin removal but some time single polymer bur was not able to remove all the stained dentin.

**References**

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Source of Support: None, Conflict of Interest: None declared