Research Article

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# Comparative Evaluation of Microhardness of Remaining Dentin after Caries Removal by Smart Burs and Conventional Diamond Burs: An In Vitro Study

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## ABSTRACT

**Background**: Dental caries continues to affect a significant portion of the world population and treatment of the decay is associated with pain by many patients. Intervention and application of rotary instruments for treatment of carious lesions has often resulted in considerable removal of tooth structure. **Aim:** The aim of the study is to evaluate and compare the microhardness of remaining dentin after caries removal using smart burs and conventional diamond burs.

**Materials and Methods:** 40 freshly extracted carious human molars were selected for this study. Each tooth was cut into mesiodistal direction with the help of diamond disc using micromotor and hence two similar sections were obtained from each tooth Thus giving us 80 carious samples from 40 carious teeth. These were randomly divided into 2 groups of 40 samples each. Group 1- The carious portion of these samples was excavated with the help of polymer bur Smartprep (SS White). Group 2-The carious portion of these samples was excavated with the help of Diamond points (No. 018).The surface of microhardness of remaining dentin of all the samples of both the groups was measured by Vickers Microhardness Tester. Data were analyzed with Independent T-Test ($P$ = 1.000). **Statistical Analysis Used:** Independent test was used in this study

**Results:** The mean scores of microhardness of remaining dentin removal by Diamond burs (group A) and Smart burs (group B) was found to be statistically insignificant

**Conclusion:** Smart bur and conventional bur was found to be comparable. Thus smart burs can be a hassel free alternative method for caries removal.

**Keywords:** Microhardness, Conventional Bur, Smart Bur, Residual dentin thickness.

## INTRODUCTION

Despite the decline of caries prevalence, dental caries continues to affect a significant portion of world population and treatment of the decay is still a challenge for researcher [1]specially for pediatric patients because of their fear and anxiety. The basic method of caries removal is caries excavation which has traditionally been performed according to mechanical principles using drills and sharp-edged hand instruments. These methods, although often effective, have some disadvantages. While removing

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caries we end up removing sound tooth structure because of the lack of objective clinical markers.

However in more recent years,with the advent of adhesive restorative materials and the subsequent developments in minimal cavity designs,the concept of G.V Black's "Extension for prevention" has changed to "conservation for prevention" which led to a more gentle comfortable and conservative caries excavation method which could aim at providing minimal thermal changes,less vibrations,pain and removal of infected dentine only.[2]

Use of conventional carbide burs involves removal of both infected as well as affected dentine along with the invariable removal of some of the healthy tooth structure.. Recently there has been introduction of self-limiting concept in the field of mechanical caries removal with the polymerburs (Smart Prep,SS White Burs Inc, Lakewood,NJ,USA).[3] These are paddle shaped with unique flute design constructed from medical grade polyether-ketone (PEKK) ,having specific hardness and wear resistance which is instrumental in removing only soft carious infected dentin thereby preserving the affected dentine. Hence ,in light of above knowledge the present study is designed to "comparative evaluate the microhardness of remaining dentine after caries removal by smart burs and conventional diamond burs."

## MATERIALS AND METHODS

40 Freshly extracted carious human molars were selected for this study. The teeth were autoclaved (121 degree celsius, 15 lbs for 15 min.) and cleaned using ultrasonic scaler to remove the debris.**(Fig 1**)

Fig 1: 40 Proximal carious teeth.

All the selected teeth were used within 3 months of collection as per recommendations of Occupational Safety and Health Administration (OSHA). Prior to their inclusion in the sample, carious lesion was confirmed according to the Erickson's criteria i.e colour ( brown to black), hardness of the lesion (medium consistency -resistance to probing but readily penetrated when tested with a sharp probe). Sampled teeth were stored in saline for the entire duration of the study to avoid dehydration.

Inclusion criteria included carious teeth involving enamel and dentin,teeth with intact buccal/lingual surface,teeth with proximal caries and exclusion criteria included teeth having crown fractured,presence of white spot lesions,hypolastic or hypomineralized teeth. The ethical clearance reference number is DJD/IEC/2017/A-27.

Each tooth was cut into mesiodistal direction with the help of diamond disc using micromotor and hence two similar sections were obtained from each tooth Thus giving us 80 carious samples from 40 carious teeth. These were randomly divided into 2 groups of 40 samples each.**(Fig 2a,2b)**

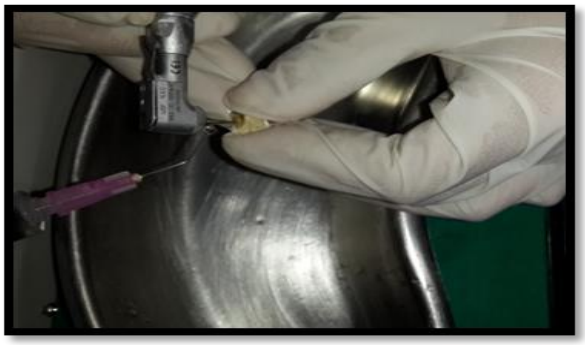


Fig 2a: Group 1.

Fig 2b: Group 2.

**Group I:** (n=40) caries was removed using the smart bur II (SS White).
**Group II:** (n=40) caries was removed using the conventional diamond bur (SS White).

Each section was washed under water for 1 minute. Caries was removed using micromotor with slow and intermittent speed using diamond burs for Group A and smart burs for Group B . An assistant was appointed to irrigate the sample throughout the procedure. The completion of caries removal was checked using Erickson's criteria i.e.{optical (colour) and tactile (hardness)}. The colour was checked visually and hardness of the lesion was checked by the dental explorer until a leather-hard texture and sharp scratching sound was heard . Once the caries removal was confirmed, sample was kept in an empty bottle and was evaluated for hardness removal within half an hour. The procedure was repeated for all the samples of both the groups. Standardized blocks of smoothened samples were prepared for determining microhardness and were mounted in such a way that cavitated part was exposed to external environment.The blocks were again smoothened.**(Fig 3a,3b)**

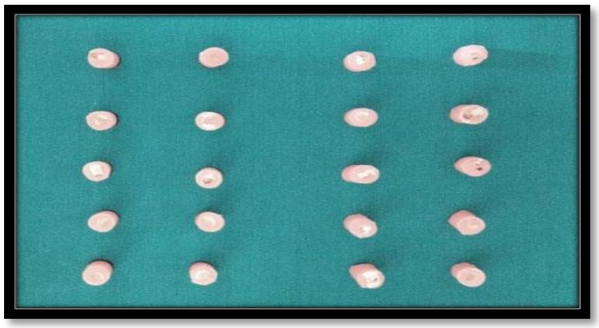


Fig 3a: Acrylic resin block for microhardness analysis for (Conventional Diamond Bur)

Fig 3b: Acrylic resin block for microhardness analysis for (Smart Burs)

Each sample was kept in the Vickers Microhardness Tester Machine one by one.The pointer of the machine made an indentation on it with 100 grams of force for 15 seconds using a diamond indenter with square base having an angle of 136 degree between the opposite sides.**(Fig 4)**

Fig 4: Digital Vickers Microhardness Tester Machine

Upon completion of indentation,the two diagonals were measured and average value was considered. Four indentations per test was performed on each sample during each experiment and the mean value derived represented the microhardness.

## RESULTS

The data was statistically analysed using independent t-test and the following results were obtained. The mean score of microhardness of remaining dentine after caries removal by conventional burs(group A) was calculated and found to be 238.5 ± 2.22 while the mean score of microhardness of remaining dentin removal by Smart burs (group B) was 229.9 ±2.153. It was noted that the mean score of microhardness of remaining dentin removal was higher in group A than in group B as mentioned in the table below (table 1)

The Inter-group comparison of various groups was done using independent t test. The mean scores of microhardness of remaining dentin removal by Diamond burs (group A) and Smart burs (group B) was found to be statistically insignificant with a P value of 1.000.(Table 2)

Table 1: Mean values of microhardness of remaining dentin in Group A and Group B

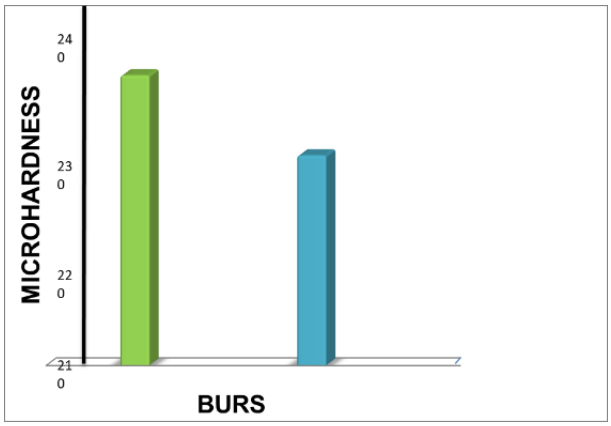
| Groups | N | Mean | Standard deviation | standard error |
|---|---|---|---|---|
| GroupA (Conventional burs) | 40 | 238.593 | 2.2298 | .3526 |
| Group B (Smart burs) | 40 | 229.957 | 2.1533 | .3679 |

*Significant (p<0.05 **Non-significant (p>0.05)

Table 2: Intergroup comparasion of microhardness of remaining dentin in Group A and Group B

| | Mean Difference | Std. Error Difference | T Value | (P value) |
|---|---|---|---|---|
| Group A(Conventional burs) Vs Group B (Smart burs) | 8.636 | 0.5242 | 43.181 | 1.000** |

Graph 1: Graphically representation of mean values of microhardness of the remaining dentin in Group A and Group B.




## DISCUSSION

Eliminating the carious lesion at a level when the tooth is still restorable is necessary for prevention of destruction of the tooth structure. Various instruments are available for removing carious lesion. The earliest attempt to remove caries by using hand instruments were initially introduced by **James Morrison** in **1871**with the help of sharp metal hand drills. But these instruments were time consuming and it was difficult to completely remove the caries with them. Hence it lead to the introduction of the first dental burs in 1891, which were machined from a single rod of steel and were used with motorized hand drills. While reasonably effective on dentin and for caries removal, they dulled rapidly when cutting sound enamel. The modern diamond bur was created in **1932** by **W.H. Drendel** along with the introduction of the high speed hand piece. Widespread acceptance of diamond burs was limited from **1939** through **1946** because of the expense and impractical shapes and sizes then available. Hence after various attempts, a major breakthrough was made with the introduction of the tungsten carbide headed burs in **1947** which was an immediate success. However, interest in diamond burs kept on growing because of the wartime critical shortage of steel, silicon carbide and other abrasive materials used in rotary cutting instruments. And finally in the same year diamond burs with different shapes and grit sizes became available which were widely accepted thereafter· **Siegel SC, Fraunhofer JAV (1998)** [4]

However, these highly efficient rotary instruments for caries removal lead to the removal of sound dentine too along with the carious dentine which lead to the weakening of the remaining tooth structure along with pain and sensitivity because of the exposed dentinal tubules. Hence there was a quest for a bur which removed only the heavily infected soft dentin and left the not so infected dentin which is hard leathery known as the affected dentin.

Thus a novel, self-limiting, bur was introduced in 2001 named smart burs(**Smart Prep, SS White Burs, Inc., Lakewood, NJ, USA**). This paddle-shaped bur has a unique flute design, and is constructed from a medical-grade polyether-ketone- ketone·[5] 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. [6]

The removal of infected dentin without affecting dentin capable of remineralization is the ultimate goal of restoration.Usually with the rotary instrument caries is removed till sound dentin is not achieved.Thus often results in weakening of remaining tooth structure as affected dentin can easily be left behind because of its minimal microbial content and capable of remineralizatiion.Polymer burs consist of cutting elements that cut softer dentin with leathery

consistency efficiently but are unable to cut normal dentin. The cutting blades will deflect and deform upon encountering normal or partially decalcified dentin,thereby enabling the reduction of cutting efficiency and alteration of the operators tactile sensation.

Microhardness of remaining dentine after caries removal was found to be more for conventional bur than smart burs. The similar results was found in the study conducted by **Correa FNP et al (2007), Qasim AS and Suliman AA (2008), Flückiger L(2008) and Jaya S et al (2011)**who concluded that the hardness of the remaining dentin after carious tissue removal was lower than that obtained on healthy dentin, without significant difference between the different means of carious tissue removal. [3,7,8,9]

Thus according to minimal invasive dentistry concepts based on the ' Prevention of Extension' theory, ideally the affected dentine should be left behind so as to conserve the sound tooth structure to the maximum. .The conventional diamond burs has a knoop hardness of 7000KHN thus has greater cutting efficiency ,and it removes both affected and infected dentin. While smart burs are made up of polyamide ketone and has knoophardness number of 50KHN. Since the KHN of smart bur is less than sound dentin (70-90 KHN) so, it become blunt when it comes in contact with it and removes only demineralization infected dentin having a (0-30KHN) leading to conservation of sound tooth structure. Similar study done by **Shakya VK ,Chandra A, Tikku AP (2012)** on comparative evaluation of dentin caries removal with polymer bur and conventional burs it was concluded that the smartprep bur is more conservative in selectively dentin caries removal than conventional burs.[10]

But when Intergroup comparison was done the microhardness of remaining dentine after caries removal was found to be statistically insignificant. (p value=1.000).. As affected dentin still has some microbial content thus its hardness was found to be little less than that of sound dentin but it was comparable to that of sound dentine.

## CONCLUSION

Within the limitation of this in vitro study the evaluation and comparasion of microhardness of the remaining dentin after caries removal using smart burs and conventional diamond burs was done and following conclusions were drawn:

1. The microhardness of the residual dentin after caries removal by smart bur was less.
2. The microhardness of the residual dentin after caries removal by conventional diamond bur was more.
3. The microhardness of the residual dentin after caries removal by the conventional diamond bur was more than that of smart burs but the difference was statistically insignificant.

## CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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