EFFECT OF DIAMOND AND CARBIDE BURS ON DENTINAL TUBULES AND PREDENTIN DIAMETER

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ABSTRACT

OBJECTIVES

To find out the effect of Diamond and Carbide burs on the diameter of dentinal tubules and predentin of premolar teeth.

METHODOLOGY

A Laboratory-based experimental study was conducted at the anatomy department, Institute of Basic Medical Sciences, Khyber Medical University, from January 2018 to March 2018. Sixty premolars were obtained from patients considering the inclusion and exclusion criteria. Six teeth were extracted for control group A. Fifty-four maxillary and mandibular premolar teeth in patients underwent cavity preparation carried out by diamond bur (group B) for twenty-seven teeth and other twenty-seven teeth by carbide bur (group C) and were removed from patients at a dental hospital in Peshawar (RCD). They underwent processing and were then stained with Eosin, Hematoxylin and Masson's trichrome to observe the diameter of dentinal tubules and predentin.

RESULTS

The dentinal tubules and predentin diameters were observed and measured in all samples in both control group A and experimental groups B and C. No effect was seen in dentinal tubules diameter. In the Control group, the diameter of predentin was less as compared to Experimental groups B and C, i.e., 10-17.5µm in group A whereas the range for Diamond bur (Group B) and Carbide bur (Group C) was 12.5-25µm and 20-37.5µm whereas.

CONCLUSION

It was concluded that in comparison with Carbide bur, Diamond bur is more beneficial than Carbide bur as the Diamond bur has no effect on dentinal tubules diameter whereas little effects on predentin diameter.

KEYWORDS: *Dental burs, Dentinal tubules, Predentin*

How to cite this article:
Momin N, Khan MH. Effect of Diamond and Carbide Burs on Dentinal Tubules and Predentin Diameter. J Gandhara Med Dent Sci. 2022;9(3): 82-86
https://doi.org/10.37762/jgmds.9-3.213

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INTRODUCTION

A dentist's time is mostly spent restoring teeth and replacing the old restorations. During these procedures, cutting tools are used that prepare cavities, remove decayed tissues and restore them[1]. The cutting tools are the handpieces, hand files, laser and burs.[2,3,4,5] The dental burs are steel burs, tungsten carbide bur and diamond bur. Steel burs were the first to be manufactured.[6] Steel burs were not efficient for cutting procedures, so tungsten carbide was introduced in 1880.[6] They have flutes and cause aggressive cutting. Due to the disadvantage of losing the shape of carbide bur during the cutting procedure, diamond burs were introduced in 1897.[7] It is the most commonly used bur both in the mouth and laboratory purposes.[8] It is resistant to wear and abrasion. The dental burs come in various shapes like round, straight, fissure, and inverted. They consist of the head, neck, and shank. The head meets the tooth. The neck is the portion between the head and shank. The shank is the area which is inserted into handpiece.[9] Preparing a cavity in a tooth produces heat by using the rotary instrument. Friction is produced during the cutting procedure that causes an increase in temperature, affecting the pulp and dentin region.[10] Temperature maintenance is important during the cutting procedure, so water coolant is used to reduce heat generated.[11] The heat produced during cutting can be measured by thermocouple by placing it on the surface of the tooth. It is a diagnostic tool for measuring temperature. Other devices that can be used are infrared thermography, miniature thermometer, and cholesterol crystal. The temperature rise depends on the duration and depth of hand piece.[12] Dental pulp maintains the vitality of tooth but if it exceeds 5.5^0C, changes occur in dentin and pulp region and the contents of dentinal tubules get displaced.[13] Dentinal tubules extend from pulp to enamel and cementum.[14] These tubules are surrounded by peritubular dentin and are connected by intertubular dentin.[15] They run in the form of S shape curvature and vary in number from 9000-to 70,000 per square millimeter.[16] These tubules decrease with age.[17] Dentinal tubules contain dentinal fluid. Dentinal fluid stimulates the nerve fibers on exposure of dentinal tubules to external stimulus, and painful conditions occurs.[18] Predentin is the inner portion of dentin located near the pulp area. The objective of this study was to observe the diameter of dentinal tubules and predentin at various sites in the tooth through a light microscope by using two stains, i.e. H&E and Masson trichrome stain.[19]

METHODOLOGY

This was an experimental study carried out in the Institute of Basic Medical Sciences (IBMS) of Khyber Medical University (KMU) Peshawar, Pakistan. The study duration was six months, i.e., from January 2018 to June 2018. Round Diamond Bur and Carbide bur were inserted into a high-speed handpiece one at a time. The pedal was pressed using water coolant, and cavities were made in the enamel and dentin portion individually by measuring it with a periodontal probe. The maxillary and mandibular premolars were collected from dental college (RCD), keeping in mind inclusion criteria, i.e., taking permanent teeth with caries not extending into dentin and exclusion criteria, i.e., teeth with carious dentin peri-apical infection, fractured enamel, dentin, cementum and root. Sixty premolar teeth were collected by purposive convenience sampling and then grouped into three groups. Extraction was performed in both males and females between 15 to 25 years for various reasons like crowding, malocclusion, etc. The fifty-four teeth for both groups B and C were collected. Each included twenty-seven teeth. The processing of tissue is important to observe the morphological structure of the tissue. For this purpose, the teeth were placed in 10% formalin (Scharlau) with the bottles marked for ease of identification to preserve teeth. In separate bottles, they were decalcified by 3% nitric acid for 3 days. Upon completion of decalcification, samples were rinsed under tap water to remove traces of nitric acid. Later, samples were room air-dried and dehydrated by immersion in increasing ethanol concentrations with strengths of 70%, 80%, and 90% in each concentration.[20] The sample was embedded in paraffin. 2 to 3 microns thick sections were cut using a microtome. The samples were placed in a warm floating water bath (60^0 C) and were picked through the slide. Samples were stained with Hematoxylin, eosin, and Masson trichrome and examined under a Light Microscope. Micrometry was done to determine the diameter of dentinal tubules and predentin. Data was entered and analyzed using SPSS version 22. Mean, and standard deviation was calculated. Independent and Paired t-tests were applied to compare the variable among the two groups. One-way ANOVA was applied for more than two variables where p-value ≤ 0.05 was considered statistically significant.

RESULTS

This experimental study was designed to observe the microscopic features of dentinal tubules and predentin of the crown and root portion in all groups A, B (Diamond bur) and C (Carbide bur). A total of 60 teeth were included in this study collected from dental college (RCD) , Peshawar. Both maxillary and mandibular premolars were selected for this study. Extracted maxillary premolars were high due to a high rate of malocclusion in the maxilla, i.e. 38 in which 6 were males and 32 females, as females are more conscious of esthetics. Table I shows that extracted mandibular premolars were low in number, i.e. 22, of which 10 were males and 12 females.

Table 1: Demographic Findings

CHARACTERISTICS	CASES
Number	60
Maxillary premolars	38 (6 males, 32 females)
Mandibular premolars	22 (10 males, 12 females)
Gender (M/ F)	16 M- 44 F
Age (Years)	18-25 Years

The frequency distribution of patient's age in all groups ranging from 18 to 25years is detailed in **(Figure 1)**. The age of the participants ranged from 18-25 yrs in all groups, having a mean of 20.47±2.2 with a $p \leq 0.05$ (Chi -square test**).**

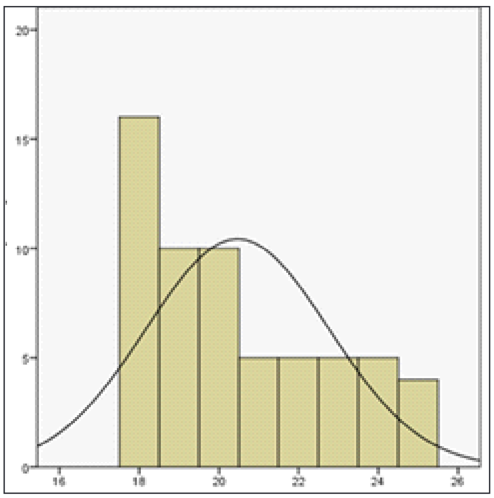

Figure 1: Comparison of Age of Patients of Study Groups, Mean± Standard Deviation, Chi-Square Test, P≤0.02

The diameter of dentinal tubules was measured at both dentin enamel junction and pulpal end. The dentinal tubules diameter was 2.5µm at DEJ and 5µm at pulpal end and remained the same in all samples shown in Figure 2 .

Hematoxylin & Eosin Stain **Masson Trichrome Stain**

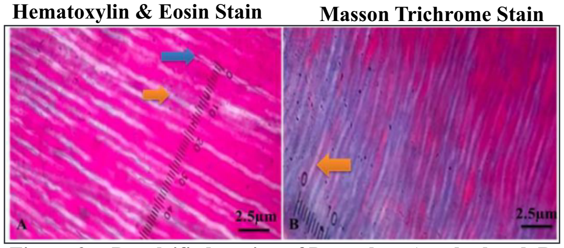

Figure 3: **Decalcified section of Premolars.A pulpal end. B DEJ.yellow arrow: Dentinal tubule, blue arrow: odontoblast processes.**

The diameter of predentin was measured from the odontoblast layer to the dentin border at different sites. In all the group's A (Control), B (Diamond bur) and C (Carbide bur), the diameter varied in different samples but remained constant throughout the length in every single sample. In six teeth (control group A), the diameter of predentin ranged from 10-17.5µm, whereas the range for Diamond bur (Group B) and Carbide bur (Group C) was 12.5-25µm and 20-37.5 shown in Figure 3.

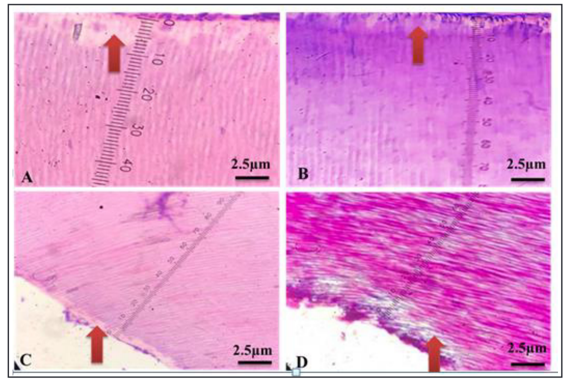

Figure 4: Decalcified Section of Premolars. Red Arrow: Predentin. A, B= Predentin Diameter of Group A (Control), C= Predentin diameter of group B (Diamond bur), D = Predentin diameter of group C.

The mean diameter of Predentin in groups A, B and C are 14.5± 2.9, 20.3± 4.3 and 23.8± 5.5, respectively, which shows that the mean diameter of predentin in Group C was higher than groups A and B. $p \leq 0.001$ One- way ANOVA showed in Figure 4 and Table 2.

Table 2: Mean Diameter of Predentin & Dentinal Tubules.

	Predentin Diameter Mean± SD	Diameter of Dentinal Tubules
Control Group A	14.583± 2.92	2.5µm-5µm
Group B (Diamond bur)	20.3± 4.3	2.5µm-5µm
Group C (Carbide bur)	23.85± 5.5	2.5µm-5µm

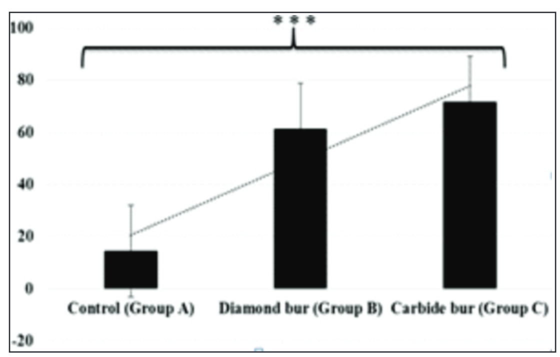

Figure 5: Overall Comparison of the Mean Diameter of Predentin in All Groups A, B and C. *** P≤0.001, One-Way Anova, ┬ Sd. The Linear Line Shows an Increase in The Diameter of Predentin in Carbide Bur (Group C).

DISCUSSION

The main aim of this study was to observe the effect of Diamond and Carbide bur in high-speed handpieces on dentinal tubules and predentin. The crux of our study findings was that histological changes do occur in these structures. As dentin and pulp are composed of collagenous proteins, Haematoxylin & Eosin and Masson trichrome stains were used to differentiate various connective tissues present in the dentin and pulp.Our observation clearly demonstrated the diameter of dentinal tubules at both the pulpal end and at the dentin enamel junction. Odontoblast processes are present within dentinal tubules and do not occupy the tubule's entire lumen, leaving some space as investigated by various authors.[21] The findings that dentinal tubules diameter is greater at pulpal than at DEJ.[22,23] The predentin region was seen extending from the odontoblast layer to dentin which was also observed by different studies. It remained constant throughout the length of crown and root, which is evident from another researcher.[24] As in this study, the distance between the odontoblastic layers of the pulp to the dentin borderline was considered for the measurement of the predentin diameter, so the mean predentin width, including all groups, measured from 10 to 37.5µm, which is the same , i.e. 10-47µm25.[25] It means that heat may affect the predentin, resulting in a widening predentin in the Diamond and Carbide bur groups. This widening of predentin was also seen by other researchers in patients with increased odontoblastic activity, ageing, and chronic renal failure, in rats fed with high sucrose diet and in patients with hypophosphatasia.[27] Keeping in view the direction of this result, it would be desirable to compare the effect of Carbide and Diamond bur in a patient with renal failure and hypophosphatasia.

LIMITATIONS

We could have expanded this study regarding data and statistical limitations by including groups like water coolant and non-water coolant groups. As we already had many study groups, the study design was kept limited.

ACKNOWLEDGEMENT

We acknowledge Mr Yasir (Lab Technologist, KMU) for technical assistance in slide preparation.

CONCLUSION

It was concluded that the diamond bur is more beneficial than the carbide bur asthe diamond bur has little effect on dentinal tubules and predentin.

CONFLICT OF INTEREST: None

FUNDING SOURCES: Nabila Momin was partially funded by Khyber Medical University as part of the M. Phil project.

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2. **Muhammad Haroon Khan** - Data Acquisition; Drafting Manuscript; Critical Revision