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EFFECT OF VARIOUS STERILIZATION AND DISINFECTION PROTOCOLS OF TOOTH PREPARATION BURS ON THEIR CUTTING EFFICIENCY AND THEIR RELATION TO THE SURFACE ROUGHNESS OF TOOTH PREPARATION – AN INVITRO STUDY

Prosthodontics

Dr. Mangipudi Krishna Sravan* Post Graduate student, KIMS Dental College and Hospital, NH – 216, Chaitanya Health City, Chaitanya Nagar, Amalapuram, 533201. *Corresponding Author

Dr. Sumeet Sharma Head of the Department, KIMS Dental College and Hospital, NH – 216, Chaitanya Health City, Chaitanya Nagar, Amalapuram, 533201.

Dr. A. Jyothi Professor, KIMS Dental College and Hospital, NH – 216, Chaitanya Health City, Chaitanya Nagar, Amalapuram, 533201.

Dr. Rizwanulla Senior Lecturer, KIMS Dental College and Hospital, NH – 216, Chaitanya Health City, Chaitanya Nagar, Amalapuram, 533201.

Dr. Chandramouli Senior Lecturer, KIMS Dental College and Hospital, NH – 216, Chaitanya Health City, Chaitanya Nagar, Amalapuram, 533201.

ABSTRACT

AIM: This study aims to evaluate the effect of sterilization and disinfection of rotary diamond burs on their cutting efficiency and their relation to their surface roughness. **MATERIALS AND METHODS:** A total of 12 (n=12) burs and acrylic typodont teeth of (n=36) were taken which consists of Diamond TF-13 (MANI) (n=6) and Tungsten carbide bur 169L bur (Prima Dental, Prima Classic) (n=6). These burs were divided into 6 groups. Each group consists of Sub Groups A & B. Sub Group A in each Group Contains Diamond TF-13 (n=1) and Sub Group B in each group contains Tungsten carbide bur 169L bur (n=1). Each single Group is subjected to different methods of sterilization and disinfection with Autoclave, Hot air oven, Ultrasonic, Glass bead, Chemical Disinfection (KORSOLEX) after the tooth preparation. Samples of crown preparation were prepared by placing the mounted tooth on a Modified Milling Machine. After each use, these diamonds and burs were sterilized for 3 cycles of tooth preparation simultaneously and the tooth were evaluated for the surface roughness with a surface profilometer and the resultant values were noted and statistically analyzed. The burs were evaluated for the surface quality under Stereomicroscope and scores were given from 0 to 5 according to the grits and wear present on the surface of the burs. **CLINICAL SIGNIFICANCE:** Diamond rotary burs should be sterilized and disinfected as it has become a mandatory protocol for the dental professionals to prevent cross-contamination and cross infection between the dentist and dental personnel. However, different sterilization and disinfection methods can have undesirable effects on the ability of the burs to effectively reduce the tooth structure. Irrespective of the type of bur and sterilization process used, the cutting efficiency decreases after multiple usage of the burs.

KEYWORDS

Sterilization, Disinfection, Surface roughness, Cutting efficiency

INTRODUCTION:

In dentistry, infection control is a major concern due to risk of transmission of communicable disease. As the field of dentistry deals with various nature of oral flora which deals with combination of both aerobic and anaerobic bacteria, the risk of cross infection can be four to five folds more in the dental personnel as well as the dentists and next line of people would be the patients, laboratory technicians. Dental burs are used in fixed prosthesis and for several purposes like tooth preparation, finishing and polishing, cavity preparation, etc., which is the major source of cross contamination, due to the necrotic tissue, saliva, blood and potential pathogens As to overcome this, sterilization and disinfection has become a mandatory protocol for the dental professionals. Due to complex architecture of dental burs, pre – cleaning and sub sequent sterilization is mandatory after every usage. So, proper attention should be taken for adequate cleaning.

The most common sterilization and disinfection methods for rotary cutting instruments are dry heat, autoclaving, microwave irradiation, and immersion in chemical solutions and Trueing & Dressing. Even though these procedures are important and found to be safe for a dental treatment, these may result in alterations in the surface and subsurface characteristics that effect the cutting efficiency. The present study aims to evaluate the effect of various sterilization and disinfection protocols of tooth preparation burs and their cutting efficiency and their relation to surface roughness of tooth preparation after subjecting them to multiple sterilization and disinfection cycles.

MATERIALS AND METHODOLOGY:

In this study, two types of burs were included; Diamond TF-13 (MANI) (n=6) and Tungsten carbide 169L bur (Prima Dental, Prima Classic) (n=6) making a total number of 12 burs (n=12), and an acrylic typodont tooth of tooth number 36 (n=36). Sample size of burs (n=12) were divided into 6 groups which were each group is further divided into Subgroups "A & B". Sub group 'A' in each group Consists of Diamond Bur TF – 13, & Sub group 'B' Consists of Tungsten Carbide FG 169L.

Grouping was done as follows:

GROUP 1	CONTROL	1A – TF-13
		1B – 169L bur
GROUP 2	AUTOCLAVE	2A – TF-13
		2B – 169L bur
GROUP 3	HOTAIR OVEN	3A – TF-13
		3B – 169L
GROUP 4	ULTRA SONIC	4A – TF-13
		4B – 169L bur
GROUP 5	GLASS BEAD	5A – TF-13
		5B – 169L bur
GROUP 6	CHEMICAL DISINFECTION (KORSOLEX)	6A – TF-13
		6B – 169L bur

Figure 1 *Figure 2* *Figure 3*

Modified Milling Machine

Diamond Tf – 13

Carbide Burs Fg 169l

Each group consisted of two types of burs, i.e, Diamond burs TF-13 (MANI) (n=6) (Figure 2) and Tungsten carbide bur 169L bur (Prima Dental, Prima Classic) (n=6) (Figure 3). A Surface Profilometer (MEXITECH SURFACE ROUGHNESS TESTER SRT-6200) (Figure 9) is used for measuring the surface roughness of the prepared tooth.

SAMPLE PREPARATION:

Each typodont tooth was mounted on a stone block (2.5 × 2.5 cm) up to 2 mm above the cementoenamel junction. The rotary diamond and burs

in each group were subjected to stereomicroscopic evaluation to evaluate the surface topography before they were used for tooth preparation and the burs which are with manufacturing defects and damaged were excluded. The specimens with the stone block were mounted on a milling unit and a standardized crown preparation procedure was followed. Each bur in the six groups were used for tooth preparation for 5 min.

Tooth preparation was done for a Metal Ceramic crown with occlusal reduction initially, followed by Labial, Lingual, and proximal reduction according to the principles of tooth preparation using Modified milling machine (Fig 1) by mounting the stone blocks in milling machine in order to standardize the tooth preparation. This modified milling machine consists of a horizontal block which allows the airoter to fit horizontally whereas the conventional Milling machine consists of the horizontal block which allows the hand piece to fit vertically.

Tooth preparation was done for 12 typodont teeth using 12 burs with an Airoter (PRIME, Allure) with 100000 Rpm turbine speed using mineral water as a coolant which is in room temperature with the diamond with a colour code of blue with the grit size 106 – 125 µm and 169LTungsten carbide bur These 12 burs were subjected to sterilization according to their respective groups. i.e, group which was selected as Control group is cleaned under running tap water and then dried, the group with Autoclave (Clinic Clave C2) (Fig 4) method of sterilization is subjected at 125°C and 0.7 kPa for 15 minutes, Hot air oven at 1800C for 30 minutes (Fig 6), Ultra - sonic (GT SONIC) method of sterilization for 5min (Fig 7), Glass bead sterilization (Lalit) for 15 to 20 seconds (Fig 6), and immersing in 10 ml of Chemical Disinfectant (KORSOLEX) for 10 minutes.

In the second cycle, another 12 typodont teeth were used for tooth preparation after the sterilization & disinfection of the burs. Simultaneously, 3 cycles of tooth preparation were done after sterilization and disinfection after each cycle, thereby making a total of 36 Samples of typodont teeth after tooth preparation.

The rotary diamond burs from each group were subjected to stereomicroscopic evaluation after each cycle to evaluate the effect of sterilization procedures on their surface topography.

Figure 4 *Figure 5* *Figure 6* *Figure 7*

Autoclave **Glass Bead** **Hotair Oven** **Ultrasonic**

Figure 8

Samples Of 1st, 2nd, 3rd Cycles Of Tooth Preparation

The rotary diamond burs from each group were subjected to stereomicroscopic evaluation after each cycle to evaluate the effect of sterilization procedures on their surface topography.

The resultant values were subjectively scored as:
Score 0: Absence of tip wear and loss of part of the diamond structure,
Score 1: Alteration in the shape of the tip structure,
Score 2: Loss of part of the diamond structure,
Score 3: Alteration in the shape and loss of part of the diamond structure,
Score 4: Alteration in the shape and loss of diamond structure, and
Score 5: Loss of diamond structure with complete exposure of metal.

The surface roughness of the prepared tooth was evaluated for the surface roughness to assess the cutting efficiency of the bur using, Surface Profilometer (MEXITECH SURFACE ROUGHNESS TESTER SRT-6200)

Figure 9

SURFACE PROFILOMETER

RESULTS:
Wilcocksen Sign Rand test and non-parametric analysis was done for all the statistical values obtained. It was shown that TF-13 diamond bur having more cutting efficiency than 169L bur of all groups generally. Whereas intergroup values were measured and shown difference in the efficiency of study groups.

Diamond which were subjected to Hot air oven showed less wear and more cutting efficiency in all three cycles than other study objects.

Hot air Oven methods of sterilization was effective followed by Ultrasonic and Autoclave. The cutting efficiency of 3rd cycle was reduced comparing to 1st cycle of tooth preparation.

The surface roughness of tooth preparation reduced in 3rd cycle compared to 1st cycle.

Even after third cycle of crown preparation, Hot air Oven Method of Sterilization showed better cutting efficiency (GROUP 3A) followed by Ultra sonic sterilization (GROUP 4A)

G1A

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	12.31	1	33.3	33.3	33.3
	12.50	1	33.3	33.3	66.7
	13.00	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G1B

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.40	1	33.3	33.3	33.3
	2.87	1	33.3	33.3	66.7
	3.14	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G2A

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	9.91	1	33.3	33.3	33.3
	10.13	1	33.3	33.3	66.7
	11.00	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G2B

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.01	1	33.3	33.3	33.3
	2.52	1	33.3	33.3	66.7
	2.97	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G3A

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18.13	1	33.3	33.3	33.3
	19.85	1	33.3	33.3	66.7
	20.12	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G3B

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.15	1	33.3	33.3	33.3
	3.85	1	33.3	33.3	66.7
	4.13	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G4A

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	11.13	1	33.3	33.3	33.3
	12.12	1	33.3	33.3	66.7
	13.05	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

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G4B					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.87	1	33.3	33.3	33.3
	2.11	1	33.3	33.3	66.7
	2.32	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G5A					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	8.13	1	33.3	33.3	33.3
	8.67	1	33.3	33.3	66.7
	9.13	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G5B					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4.11	1	33.3	33.3	33.3
	4.77	1	33.3	33.3	66.7
	5.13	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G6A					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10.02	1	33.3	33.3	33.3
	10.51	1	33.3	33.3	66.7
	11.13	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

G6B					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.11	1	33.3	33.3	33.3
	2.85	1	33.3	33.3	66.7
	3.16	1	33.3	33.3	100.0
	Total	3	100.0	100.0	

		N	Mean Rank	Sum of Ranks
G1B - G1A	Negative Ranks	3[a]	2.00	6.00
	Positive Ranks	0[b]	.00	.00
	Ties	0[c]		
	Total	3		
G2B - G2A	Negative Ranks	3[d]	2.00	6.00
	Positive Ranks	0[e]	.00	.00
	Ties	0[f]		
	Total	3		
G3B - G3A	Negative Ranks	3[g]	2.00	6.00
	Positive Ranks	0[h]	.00	.00
	Ties	0[i]		
	Total	3		
G4B - G4A	Negative Ranks	3[j]	2.00	6.00
	Positive Ranks	0[k]	.00	.00
	Ties	0[l]		
	Total	3		
G5B - G5A	Negative Ranks	3[m]	2.00	6.00
	Positive Ranks	0[n]	.00	.00
	Ties	0[o]		
	Total	3		
G6B - G6A	Negative Ranks	3[p]	2.00	6.00
	Positive Ranks	0[q]	.00	.00
	Ties	0[r]		
	Total	3		

a. G1B < G1A
b. G1B > G1A
c. G1B = G1A
d. G2B < G2A
e. G2B > G2A
f. G2B = G2A
g. G3B < G3A
h. G3B > G3A
I. G3B = G3A
j. G4B < G4A
k. G4B > G4A
l. G4B = G4A
m. G5B < G5A
n. G5B > G5A
o. G5B = G5A
p. G6B < G6A
q. G6B > G6A
r. G6B = G6A

DISCUSSION:

The rotary cutting burs used in fixed prosthodontics are generally electroplated, composed of high-resistant metals, such as steel or stainless steel with small gaps or depressions in which the diamond particles are electroplated. On repeated sterilization, the metal matrix of the electroplated diamond is vulnerable to corrosion and changes in the molecules of the bonding agent that make it more frail to resist the spread of tension during function, leading to the crater formation by the loss of diamond particles, which thereby reduces its cutting efficiency.

In this study, it focused on to evaluate the cutting efficiency of tooth preparation burs after various sterilization and disinfection protocols. Thereby determining type of sterilization method that which best suits with minimal amount of wear that are commonly used for tooth preparation in fixed prosthodontics. As the rotary diamond bur can be a mode of transmission of infectious diseases like hepatitis B, herpes virus, and human immunodeficiency virus through blood, saliva, and soft tissue, it has become a mandatory protocol to sterilize and disinfect the burs to overcome the risk of cross infection. The mechanism of sterilization in autoclave has been suggested to interfere in the durability and cutting effectiveness of instruments used in the dental office, due to corrosion and making the surface alterations of the burs.

Each bur after the tooth preparation, was evaluated for the surface quality and the surface roughness of the tooth was evaluated with the surface profilometer to assess the cutting efficiency of the bur after 1st, 2nd and 3rd cycles respectively.

It has been concluded that the cutting efficiency of the diamonds are better than 169L bur. The diamonds showed less wear than the 169L bur when subjected to hot air oven. The cutting efficiency when evaluated under Surface profilometer, reduced from 1st cycle of tooth preparation to the 3rd cycle.

Surface alterations of the bur when examined under stereomicroscope, revealed more surface alterations of the diamond when compared to 169L bur. Similarly, more surface alterations are observed with the burs that are subjected to chemical method of sterilization (KORSOLEX) as the bur undergoes corrosion due to the chemical substances present in the disinfectant.

Few authors such as Siegel et al. and Savage et al., justified the possible corrosion caused as being due to the humid head, Nevertheless, our results showed that the test specimens prepared with the conventional diamond- coated burs, sterilized in autoclave.

Fais et al. evaluated the, influence of different types of sterilization on the cutting effectiveness of carbide burs and verified that the oven was the method that least affected the cutting capacity of these burs.

Whereas, in 2011, Spranley et al., in a similar study concluded that up to 10 cycles of autoclaving did not significantly affect the cutting efficacy in cavity preparation.

There is a term called “Total Profile”, which means during tooth preparation, the rotary instrument machined a highly complex surface that consisted of roughness, waviness, straightness, and other similar error forms. These different forms can be quantified by Profilometer with parameters Ra, Rq, Ry and Rz.

Ra indicates initial value of the stylus pen when moved To and fro and then correlating that value, Rz (Final value) is given by the Profilometer.

Generally, the cutting efficiency of the bur can be increased even though it wears off by two methods called “Trueing” &” Dressing.”

Trueing is that which creates a smooth surface on the wheel periphery, and with no exposed grit the wheel won't cut.

Dressing sharpens the wheel by removing bond material and fracturing the super abrasive grit to expose fresh edges.

So, Generally Dressing always follows trueing.
It was known that any object treated with the chemical substances will

have minor or negligible surface alteration like corrosion, tarnish, discoloration. In the same way, burs when sterilized, will lose its properties.

CONCLUSIONS:

It was known that any object treated with the chemical substances will have minor or negligible surface alteration like corrosion, tarnish, discoloration. In the same way, burs when sterilized, will lose its properties. Generally, any dental burs used for tooth preparation, cavity preparation are designed for a single time use. But, in a private clinical practice we tend to use for multiple times after several times of sterilization which results in reducing the cutting efficiency of a bur.

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