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# Comparison of cutting efficiency of tungsten carbide and diamond burs on nickel–chromium casting alloy - An *in vitro* study

Pravinya Sam, Suresh Venugopalan, M. Dhanraj, Ashish R. Jain\*

## ABSTRACT

**Background:** Even with the advances in materials and technologies in constructing crown and bridge, failure and the need to replace crown and bridge occur all the time. When the conservative methods to remove the crown and bridge fail, destructive disassembly of the prosthesis has to be carried out. Cutting through the crown with burs is time consuming and tiring. **Aim:** The aim of this study is to evaluate the cutting efficiency of tungsten carbide bur and diamond burs in sectioning nickel–chromium dental casting. **Materials and Methods:** A total of 20 metal rods from a base metal alloy (Ni-Cr) rods were used for this study. The rods were divided into two groups. Group A was cut using SSW FG-271 tungsten carbide bur and Group B was cut using SF-11 diamond burs using a high-speed handpiece for a constant time of 1 min by a single operator. The cutting efficiency of each bur was evaluated corresponding to the weight loss. **Result:** There was a statistically significant difference ( $<0.05$ ) in the mean material loss between the different groups in independent sample *t*-test. **Conclusion:** Cutting efficiency depends on the diamond bur grit size and duration of the cutting procedure and many other factors. The cutting efficiency of the bur in zirconia and porcelain should also be considered while making the decision.

**KEY WORDS:** Base metal, Dental burs, Dental casting alloys, Diamond abrasives, High-speed handpiece, Tungsten carbide burs

## INTRODUCTION

Metal-ceramic restorations have been available for more than three decades. They have predictable performance and reasonable esthetics. Even with the advances in materials and technologies in fabricating a crown and bridge, occurrences of failure and the need to replace crown and bridge happen from time to time. Failure of crown and bridges occurs for a number of reasons.<sup>[1]</sup> The tooth holding the crown might fail fracture of ceramics, incorrect cementation, connector failure, periodontally compromised abutment, and fractured tooth structure.

In cases with failed crowns and bridges, removal of the failed crown and the replacement is indicated.<sup>[2,3]</sup> There are many instruments and techniques newly developed for removing the failed crown and

bridges which employs percussion or torquing methods.<sup>[4]</sup>

There are limitations to these techniques, and they are not always successful as claimed. In those conditions, the dentist is left with the option of sectioning the crowns.<sup>[5]</sup> Cutting through the crown with burs is time consuming and tiring. Bur manufacturers have introduced specialized metal cutting diamonds as well as tungsten carbide burs.<sup>[6]</sup>

The ability of the instrument to remove the maximum amount of material with minimum effort and time is the cutting efficiency. The cutting efficiency of tungsten carbide burs depends on various design factors such as helix angle, sharpness and number of cutting edges, concentricity, and quality of carbide steel.<sup>[7]</sup>

This study evaluates the cutting efficiency of tungsten carbide bur and diamond burs in sectioning nickel–chromium dental casting. The aim of this study is to evaluate the cutting efficiency of tungsten carbide

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ISSN: 0975-7619

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Received on: 27-02-2018; Revised on: 23-04-2018; Accepted on: 24-05-2018

bur and diamond burs in sectioning nickel–chromium dental casting.

## MATERIALS AND METHODS

20 metal rods from a base metal alloy (Ni-Cr) rods were used for this study. The rods were divided into two groups. Each of the metal rods was weighed individually and documented. The rods were rigidly secured with a holding frame [Figure 1].

Group A was cut using SSW FG-271 tungsten carbide bur and Group B was cut using SF-11 diamond burs using a high-speed hand piece for a constant time of 1 min by a single operator.

The metal rods were weighed after the procedure, and they were again weighed [Figure 1]. The data obtained were entered into Microsoft Excel spreadsheet, and the mean difference in weight between the groups was calculated. The data were then entered in the SPSS software and analyzed.

## RESULTS

The average amount of metal loss (difference between initial weight and the weight after cutting using dental burs) from each group was measured [Table 1]. The amount of metal loss was greater in the group with diamond burs [Figure 2]. Statistical analysis was performed using SPSS software.

Independent sample t-test was carried out for the values obtained from both the groups. There was a statistically significant difference ( $<0.05$ ) in the mean material loss between the different groups.

## DISCUSSION

This study showed that the diamond burs are more effective in cutting through nickel–chromium

alloys in a given period of time when compared to tungsten carbide bur. The results of this study were in contrast to a previous study according to which medium-grit diamond burs should be used to section high noble and noble alloys, but the cross-cut carbide burs should be used to section base metal alloys.<sup>[8]</sup>

The sectioning rates of tungsten carbide burs and diamond burs differed among the alloys. There are many factors that contribute to the overall sectioning rates. With tungsten carbide burs, the hardness of the metal alloy should be lesser than that of the bur used for the burs to efficiently cut the metal.<sup>[8]</sup>

Diamond burs have one or more layers of diamond chips attached to the metal head by electrodeposition. Due to the differences in the size of the diamond particles, diamond burs are available in different



Figure 1: Metal rods and weighing machine

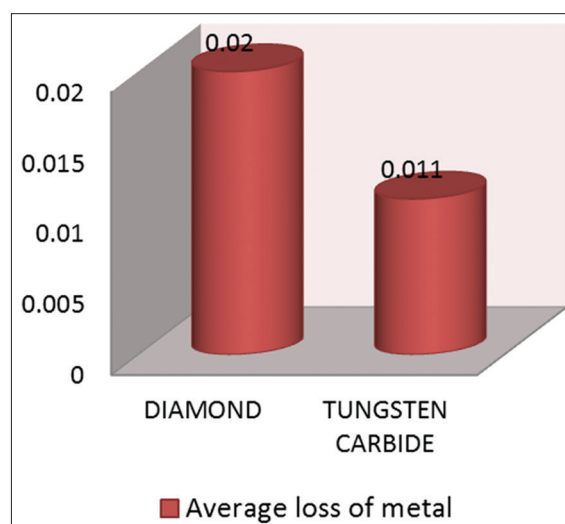


Figure 2: Metal loss with diamond burs in both groups

Table 1: Amount of material loss (mean and SD)

Groups	Amount of metal cut (g)
Diamond (Group 1)	0.02±0.014
Tungsten carbide (Group 2)	0.011±0.007

SD: Standard deviation

Group Statistics					
	GROUP	N	Mean	Std. Deviation	Std. Error Mean
METALLOSS	1.00	10	.0200	.00816	.00258
	2.00	10	.0110	.00316	.00100

Independent Samples Test											
		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
									Lower	Upper	
METALLOSS	Equal variances assumed	5.335	.033	3.250	18	.004	.00900	.00277	.00318	.01482	
	Equal variances not assumed			3.250	11.641	.007	.00900	.00277	.00295	.01505	

coarseness. The grit size of the diamond bur acts as a deciding factor in cutting efficiency.<sup>[9]</sup>

This may be because of the use of unused diamond burs; there are studies that indicate the decrease in cutting efficiency of dental burs with multiple uses. The mean cutting rates for all bur types decreased approximately 20% with 20 cuts.<sup>[10]</sup>

There are certain other factors that influence the cutting efficiency of burs such as the amount of pressure, length of bur, bur type, and length of use significantly influenced cutting rate.

Cutting efficiency depends on both the diamond grit of the bur and the load applied to the handpiece and an increased handpiece pressure raises the cutting efficiency of burs.<sup>[10]</sup>

Cooling efficiency of the handpiece also influences the cutting rates. The coolants incorporated help to remove the debris accumulating between the cutting blades as well as between the diamond grits in diamond burs. The coolant also helps in minimizing the thermal injury to the pulp. Higher coolant flow rates promote cutting efficiency.<sup>[11,12]</sup>

The pressure applied while cutting also affects the cutting efficiency of the burs and also plays a role in the cutting efficiency. If the pressure is applied to the handpiece, cutting efficiency of coarse grit bur was considerably increased. No such changes were observed in medium grit burs.<sup>[13,14]</sup> The cutting efficiency also depended on the debris accumulation between the diamond chips. With the accumulation of debris between the chips, there was a decrease in the cutting efficiency.<sup>[10]</sup>

With regard to the time, the efficiency of diamond burs decreases with prolonged usage due to loss of diamond abrasive particles. Sterilization of the burs and the technique used for sterilization also influence the cutting efficiency of the burs. With sterilization using ultrasonic, unit loss of diamond grits was greater. With tungsten carbide burs on sterilization with ultrasonic sterilization units, there was the appearance of pits on the cutting surface due to loss of material.<sup>[15-17]</sup>

Sectioning efficiency of burs depends on a wide range of factors. It is the dentists call to use which bur for sectioning cast metal restorations.

## CONCLUSION

The diamond burs sectioned the nickel–chromium alloy significantly more efficient than the tungsten carbide bur. Cutting efficiency depends on the diamond bur grit size and duration of the cutting procedure and many other factors. The cutting efficiency of the bur

in zirconia and porcelain should also be considered while making the decision.<sup>[18,19]</sup>

Although there is a decrease in cutting efficiency of diamond burs with prolonged cutting, the result of this study shows that a new diamond bur is significantly better in cutting Ni–Cr cast alloy than a new tungsten carbide bur.<sup>[20]</sup>

The limitations in the sample size as well as the fact that most of the factors that influence the cutting efficiency not being maintained as constants may be limiting the outcome of this study.

Using an efficient bur for sectioning the crowns will save a lot of time and energy. To assess the cutting efficiency of different burs, elaborate studies are needed to assess the various factors involved in determining the cutting efficiency. All the factors that can influence the cutting efficiency should be assessed. Burs with hardness greater than the metal to be cut should be used.

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Source of support: Nil; Conflict of interest: None Declared