International Journal of Applied Dental Sciences 2025; 11(3): 161-165

ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2025; 11(3): 161-165

www.oraljournal.com
Received: 07-04-2025
Accepted: 10-05-2025

Dr. Aishwarya Gholap
PG Student, Department of Prosthodontics, Government Dental College & Hospita, Chhatrapati Sambhajinagar, Maharashtra, India

Dr. Akanksha Mukwane
PG Student, Department of Prosthodontics, Government Dental College & Hospital, Chhatrapati Sambhajinagar, Maharashtra, India

Dr. Kishor Mahale
HOD, Department of prosthodontics, Government Dental College & Hospital, Chhatrapati Sambhajinagar, Maharashtra, India

Dr. Smita Khalikar
Professor, Department of Prosthodontics, Government Dental College & Hospital, Chhatrapati Sambhajinagar, Maharashtra, India

Dr. Vilas Rajguru
Associate Professor, Department of Prosthodontics, Government Dental College & Hospital, Chhatrapati Sambhajinagar, Maharashtra, India

Dr. Sonali Mahajan
Associate Professor, Department of Prosthodontics, Government Dental College & Hospital, Chhatrapati Sambhajinagar, Maharashtra, India

Dr. Ulhas Tandale
Associate Professor, Department of Prosthodontics, Government Dental College & Hospital, Chhatrapati Sambhajinagar, Maharashtra, India

Corresponding Author:
Dr. Aishwarya Gholap
PG Student, Department of Prosthodontics, Government Dental College & Hospita, Chhatrapati Sambhajinagar, Maharashtra, India

Comparative evaluation of cutting efficiency of different grit sizes burs on different cad/cam materials

Aishwarya Gholap, Akanksha Mukwane, Kishor Mahale, Smita Khalikar, Vilas Rajguru, Sonali Mahajan and Ulhas Tandale

DOI: https://www.doi.org/10.22271/oral.2025.v11.i3c.2201

Abstract

Statement of Problem: The use of CAD/CAM in dentistry has become more widespread. Despite this, limited attention has been paid to the challenges clinicians face when cutting different CAD/CAM restorations intraorally. Additionally, there is insufficient evidence regarding the optimal grit size and type of rotary instrument for their effective cutting.

Aim: To compare the Cutting Efficiency of Different Grit Sizes Burs on different CAD/CAM Materials

Introduction: The cutting efficiency of dental burs plays a crucial role in the preparation of CAD/CAM materials like zirconia and polymethyl methacrylate (PMMA). The aim of this study is to evaluate the cutting efficiency of different grit sizes of diamond burs on zirconia and PMMA cuboid chips, assessing their performance in terms of surface roughness & cutting depth.

Materials and Methodology: This in-vitro study used CAD/CAM fabricated cuboid chips of zirconia and PMMA. The cutting efficiency of three different grit sizes of diamond burs (fine, medium, and Standard) was evaluated. Cutting depth and surface roughness of the samples was evaluated and compared.

The experiment was repeated for 7 zirconia and 7 PMMA chips for 3 different grit sizes burs and statistical analysis was done.

Results: Extra-fine burs likely resulted in smoother surfaces for both Zirconia and PMMA samples Cutting depth was achieved more with Fine bur in Zirconia samples this can be because of increase in surface area while in PMMA samples, Standard burs exhibited more cutting depth

Conclusion: Understanding the optimal bur grit size for different materials helps clinicians achieve better occlusal adjustments, enhance patient comfort, and extend restoration lifespan. For efficient cutting, fine burs are recommended for zirconia, while standard burs work well for PMMA. For occlusal adjustments, extra fine burs are ideal for both materials, ensuring less surface roughness. This study offers valuable guidance on selecting the right diamond rotary instrument for crown sectioning and occlusal adjustments in CAD/CAM zirconia and PMMA restorations, minimizing damage risk and reducing procedure time for better patient outcomes.

Keywords: CAD CAM, Zirconia, PMMA, diamond rotary burs, grit size, cutting efficacy

1. Introduction

With advancements in digital dentistry, CAD/CAM materials such as zirconia and PMMA have become essential for fabricating prosthetic restorations, including crowns, bridges, and implant-supported prosthesis [1]. Zirconia is widely recognized for its strength and durability, while PMMA is favored for its aesthetic properties and temporary restorations. Both materials present unique challenges during chair side occlusal adjustments. The use of zirconia in dentistry has grown significantly due to its outstanding mechanical properties, biocompatibility, and satisfactory aesthetics [2]. Its rising popularity has created a need for tools capable of efficiently cutting zirconia for tasks such as occlusal adjustments, preparing endodontic access cavities, or removing failed restorations [3]. Zirconia's hardness, about 1300 VHN, is much higher than that of other dental ceramics like lithium disilicate glass-ceramic (below 735 VHN) and leucite glass-ceramics (615 VHN) [4]. Cutting zirconia in clinical practice is often challenging and time-consuming, leading to rapid wear of rotary instruments, extendedchair time, and patient discomfort. Additionally, the heat and stress generated during grinding can destabilize zirconia's polymorphic t-phase, causing phase changes influenced by factors like the type of grinding tool, speed, applied force, and grit size of rotary instruments [5]. These phase changes, combined with cracks and surface flaws created during grinding, can weaken zirconia and reduce its clinical performance and durability [6].

Diamond rotary instruments have been found to be more effective than tungsten carbide instruments for cutting zirconia [7]. These tools typically have diamond particles bonded to the cutting surface, and their effectiveness is influenced by the grit size of the abrasive particles [8]. Research has shown that smaller grit sizes minimize subsurface damage when adjusting dental porcelain, though zirconia's much highe hardness makes it more difficult to cut [9].

Specialized diamond instruments designed for zirconia claim to minimize heat and stress during cutting. Yet, studies have reported no significant difference in cutting efficiency between these specialized tools and conventional diamond instruments within the first few minutes of use [10]. There is also anecdotal evidence suggesting that finer-grit instruments may be more efficient due to their increased cutting surface area relative to the substrate [11].

Although the cutting efficiency of diamond rotary instruments with different grit sizes has been investigated, most studies have only compared limited grit sizes. There is insufficient research covering the available grit sizes or providing conclusive evidence about which grit size is best for cutting zirconia [12]. Additionally, manufacturers often do not disclose the grit sizes of their instruments, making it harder to determine the optimal tool for cutting zirconia restorations. This lack of data highlights the need for further research to identify the most effective rotary instruments for zirconia preparation [13].

Occlusal adjustments are critical in ensuring the functional and aesthetic success of CAD/CAM crowns [14]. These adjustments involve modifying the occlusal surface to achieve proper contact with opposing teeth, enhance patient comfort, and prevent issues such as premature wear or occlusal trauma [15]. The choice of bur grit size plays a significant role in the efficiency and outcome of these adjustments, impacting material removal rates, surface finish, and overall crown integrity [16]. This study evaluates and compares the cutting efficiency of different grit sizes of burs on various CAD/CAM material. The research examines the relationship between bur grit size-standard, fine and extra fine-and key performance metrics such as cutting depth and surface roughness.

Aim: To compare the Cutting Efficiency of Different Grit Sizes Burs on different CAD/CAM Materials

OBJECTIVES

1. To evaluate and compare the Cutting Efficiency of Different Grit Sizes Burs on Definitive restorative material (Zirconia)
2. To evaluate and compare the Cutting Efficiency of Different Grit Sizes Burs on a Provisional restorative material (PMMA)

Materials and Methods

1. Materials

- Zirconia Blocks
- PMMA Blocks
- **Burs:** Diamond burs of three different grit sizes: Standard, Fine, Extrafine (Mani)
- **Equipment:** A CAD/CAM milling machine (Densply sirona)
- Surface roughness tester
- Contracer machine
- Stone block to mount samples

2. Sample Preparation: STL file was designed for a Cuboid chip of dimension 10mm x 10mm x 1.5mm. (Fig1.) Prepared file was milled in CAM and Zirconia and PMMA blocks were prepared (Fig. 2). A total of 14 samples were used (7 Zirconia and 7 PMMA). Samples were mounted on a stone block during testing.

3. Cutting Efficiency Evaluation

Sample was cut using the diamond burs for a specific time (15 seconds) and at constant pressure. Depth of the indentations were made on the samples. (Fig.3) The indentations on the samples were measured using Contracer machine (Fig 4) to evaluate the cutting efficiency. After cutting, the surface roughness of the indentations on each sample was measured using a surface roughness tester. (Fig. 5)

Results

The significance level was assigned at $\alpha \leq 0.05$. P value-0.0001 for surface roughness and cutting efficiency for both the samples hence results are significant.

1. Surface Roughness

Extra-fine burs likely resulted in smoother surfaces for both Zirconia and PMMA samples (Table No. 1) Zirconia have shown less variation in surface roughness between fine and extra-fine burs, indicating that Zirconia's strength and toughness making it more resistant to roughening under different bur types.

2. Cutting Efficiency: Cutting depth was achieved more with Fine bur in Zirconia samples this can be because of increase in surface area while in PMMA samples, Standard burs exhibited more cutting depth Standard burs offers faster material removal but at the cost of higher surface roughness. (Table no. 1)

Figure format

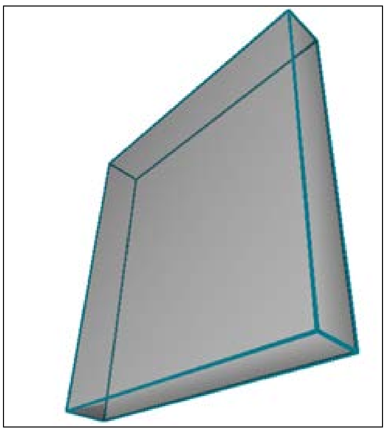

Fig 1: STL File of Cuboid Chip

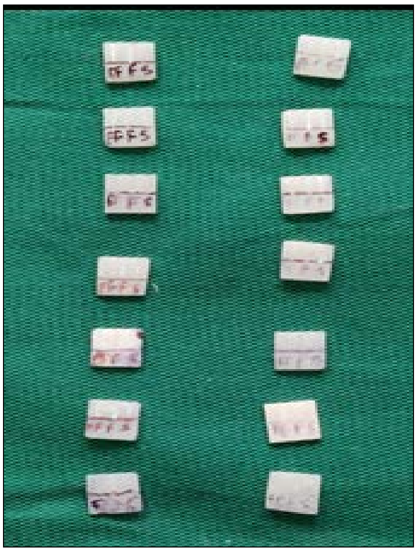

Fig 2: Zirconia & PMMA Samples

Fig 3: Depth Indentation

Fig 4: Contracer

Fig 5: Surface roughness Tester

Tables

The table should be made as simple as possible. Only a few horizontal lines should be used without vertical lines in the table. All tables should be placed after references in the manuscript. Each table should be consecutively numbered in Arabic numerals with a self-descriptive heading and/or legend. Any abbreviation or symbol used in the table should be described in the legend. The same data should not be represented in tables and in graphs.

Table Format - It should be designed using table tools of MS Word and exactly same as below

Table 1: Intragroup comparison of surface roughness and cutting depth of different grit sizes burs on zirconia and PMMA samples

Group	Parameter	Standard bur	Fine bur	Extra fine bur
Surface Roughness of Zirconia Samples with different grit sizes burs	Average	2.40	1.40	0.56
	SD	0.036	0.039	0.02
	F - 5394.59, *P*>0.0001*			
Surface Roughness of PMMA Samples with different grit sizes burs	Average	2.96	2.35	0.55
	SD	0.02	0.02	0.02
	F - 23550.5, *P*>0.0001*			
Cutting depth of the indentations made on Zirconia Sample	Average	0.49	0.53	0.41
	SD	0.02	0.01	0.02
	F - 54.36, *P*>0.0001*			
Cutting depth of the indentations made on PMMA Sample	Average	0.27	0.12	0.15
	SD	0.02	0.01	0.02
	F - 102.01, *P*>0.0001*			

Discussion

The findings of the present study align closely with those of Aswegen *et al.*, who concluded that fine grit rotary instruments, specifically within the 40-50 µm range, were the most efficient in achieving optimal cutting depth while maintaining the integrity of zirconia. Their study demonstrated that these fine grit burs provided effective material removal with no visible macroscopic damage and exhibited minimal deterioration of the instrument itself, making them a preferred choice for zirconia adjustments.[1-2] Furthermore, Song *et al*. highlighted the significant influence of diamond grit size on substrate damage. Their research determined that finer grit sizes should be used when adjusting dental porcelain, as coarser grits tend to cause increased subsurface damage. This finding reinforces the importance of selecting the appropriate bur grit size to preserve material integrity and minimize potential microfractures in restorative materials [5-8].

As per Siegel *et al*, the cutting efficiency of diamond burs with varying grit sizes on different CAD/CAM materials has been extensively studied. Research indicates that coarser grit diamond burs often exhibit higher cutting efficiency, particularly during initial cutting phases. However, this efficiency tends to decrease over time, and the rate of decline can vary based on the grit size and the material being cut. For instance, a study found that while there was no significant difference in cutting rates among medium, coarse, and super-coarse grit diamond burs during the initial cut, over extended cutting periods, super-coarse grit burs maintained higher efficiency compared to medium grit burs [3, 7].

Another investigation assessed the cutting efficiency of diamond grinders on zirconia and resin-based composite materials. The study concluded that the removal capacity varied depending on the material and the type of grinder used, emphasizing the importance of selecting appropriate burs tailored to specific materials to optimize cutting performance [9, 12].

The material properties of zirconia and polymethyl methacrylate (PMMA) further underscore the importance of bur grit selection. Zirconia, known for its high strength and fracture resistance, presents a challenge in terms of cutting efficiency. Its durability often results in slower cutting rates and can contribute to increased wear on the burs used during occlusal adjustments. Conversely, PMMA, being a softer material, allows for quicker cutting. However, excessive or aggressive adjustments can compromise its surface smoothness, potentially affecting the final restoration's fit and comfort [1, 13].

Understanding the optimal bur grit size for each material is essential for clinicians aiming to achieve precise occlusal adjustments [14]. Proper selection not only enhances the efficiency of the procedure but also contributes to improved patient comfort and the longevity of dental restorations. In clinical practice, the use of fine grit burs is recommended for occlusal adjustments to ensure smooth surface finishes, whereas standard burs are more appropriate for crown removal procedures where a higher material removal rate is required [15]. This targeted approach helps minimize unnecessary surface roughness and ensures the integrity of the restorative material, ultimately leading to superior clinical outcomes. By adhering to these findings, clinicians can optimize their techniques, enhance restoration longevity, and improve the overall patient experience in dental restorations [17].

Conclusion

1. Understanding the optimal bur grit size for each material can help clinicians achieve better results in occlusal adjustments, improve patient comfort, and extend the lifespan of restorations.
2. For efficient cutting like in crown removal Fine bur is recommended Zirconia Samples, while standard burs can be used for PMMA samples.
3. For occlusal adjustment Extra fine burs are recommended for both Zirconia & PMMA due to less Surface Roughness after cutting using extra fine burs.
4. This study provides valuable insights for dental practitioners in selecting the appropriate diamond rotary instrument for crown sectioning and occlusal adjustment n CAD/CAM zirconia and PMMA restorations.
5. Practitioners can minimize the risk of damage and reduce the time required for crown removal, improving patient outcomes.

Acknowledgments

Nill

Author's Contribution

Not available

Conflict of Interest

Not available

Financial Support

Not available

References

1. van Aswegen A, de Wet FA, Paleker F, Sykes LM. A comparative study of the cutting efficiency of diamond rotary instruments with different grit sizes with a low-speed electric handpiece against zirconia specimens. J Prosthet Dent. 2024;131(1):101.e1-8. doi:10.1016/j.prosdent.2023.10.004
2. Borzangy S, El-Damanhoury H, Amin A, Abdelraheem R. Cutting efficiency of different dental diamond rotary instruments for sectioning monolithic zirconia and lithium disilicate crowns. BMC Oral Health. 2024;24(1):1135. doi:10.1186/s12903-024-04901-7
3. Siegel SC, Patel T. Comparison of cutting efficiency with different diamond burs and water flow rates in cutting lithium disilicate glass ceramic. J Am Dent Assoc. 2016;147(10):792-6. doi:10.1016/j.adaj.2016.03.006
4. Türp L, Eichenberger M, Thoma DS, Sailer I. Influence of different cutting instruments and rotational speeds on heat generation and cutting efficiency when sectioning different types of zirconia. *J Mech Behav Biomed Mater. 2024;160:106715. doi:10.1016/j.jmbbm.2024.*106715
5. Funkenbusch PD, Sarkar NK, Knap FJ, Makovicky M. Multivariate evaluation of the cutting performance of rotary instruments with electric and air-turbine handpieces. J Prosthet Dent. 2016;116(4):558-563. doi:10.1016/j.prosdent.2016.03.002
6. Galindo DF, McLaren EA, Peters MC, Johnston WM. Tooth preparation: a study on the effect of different variables and a comparison between conventional and channeled diamond burs. J Prosthodont. 2004;13(1):3-16. doi:10.1111/j.1532-849X.2004.04003.x
7. Siegel SC, von Fraunhofer JA. Comparison of sectioning rates among carbide and diamond burs using three casting alloys. J Prosthodont. 1999;8(4):240-244. doi:10.1111/j.1532-849x.1999.tb00045.x
8. Song XF, Yin L. The quantitative effect of diamond grit size on the subsurface damage induced in dental adjustment of porcelain surfaces. Proc Inst Mech Eng H. 2010;224(10):1185-94. doi:10.1243/09544119JEIM737
9. Rosentritt M, Strasser T, Mueller MM, Schmidt MB. Cutting efficiency of diamond grinders on composite and zirconia. Materials (Basel). 2024;17(11):2596. doi:10.3390/ma17112596. PMID: 38893860; PMCID: PMC11173512
10. Peters OA, Du D, Ho MY, Chu R, Moule A. Assessing the cutting efficiency of different burs on zirconia substrate. Aust Endod J. 2019;45:289-297.
11. Go H, Park H, Lee J, Seo H, Lee S. Effect of various polishing burs on surface roughness and bacterial adhesion in pediatric zirconia crowns. Dent Mater J. 2019;38:311-316.
12. Nakamura K, Katsuda Y, Ankyu S, *et al.* Cutting efficiency of diamond burs operated with electric high-speed dental handpiece on zirconia. Eur J Oral Sci. 2015;123:375-80.
13. Lee KR, Choe HC, Heo YR, Lee JJ, Son MK. Effect of different grinding burs on the physical properties of zirconia. J Adv Prosthodont. 2016;8:137-143.
14. Miyazaki T, Nakamura T, Matsumura H, Ban S, Kobayashi T. Current status of zirconia restoration. J Prosthodont Res. 2013;57:236-261.
15. Vagkopoulou T, Koutayas SO, Koidis P, Strub JR.

Zirconia in dentistry: Part 1. Discovering the nature of an upcoming bioceramic. Eur J Esthet Dent. 2009;4:130-151.
16. Hynková K, Özcan M, Voborná I. Composition and mechanical properties of contemporary CAD/CAM glass ceramics. Ital J Dent Med. 2020;5:63-69.
17. Candido LM, Fais LMG, Reis JMSN, Pinelli LAP. Surface roughness and hardness of yttria stabilized zirconia (Y-TZP) after 10 years of simulated brushing. Rev Odontol Unesp. 2014;43:379-383.

How to Cite This Article
Gholap A, Mukwane A, Mahale K, Khalikar S, Rajguru V, Mahajan S, *et al*. Comparative evaluation of cutting efficiency of different grit sizes burs on different cad/cam materials. International Journal of Applied Dental Sciences 2025; 11(3): 161-165.