Journal of Dentomaxillofacial Radiology, Pathology and Surgery

Summer 2018, Volume 7, Number 2

# Research Paper: The Effects of Different Sterilization Methods on the Uniformity of Diamond Dental Burs and Changes in the Cutting Edge Carbide Burs

**Ilnaz Pournasiri[1], Hamid Neshandar Asli[1], Reza Abbaspour[2], Dina Maleki[3*]**

*1. Department of Prosthodontics, Faculty of Dentistry, Guilan University of Medical Sciences, Rasht, Iran.*
*2. General Practitioner, Faculty of Dentistry, Guilan University of Medical Sciences, Rasht, Iran.*
*3. Dentistry Student, Student Research Committee, Dental Research Center, Faculty of Dentistry, Guilan University of Medical Sciences, Rasht, Iran.*

Use your device to scan and read the article online

**Citation** Pournasiri I, Neshandar Asli H, Abbaspour R, Maleki D. The Effects of Different Sterilization Methods on the Uniformity of Diamond Dental Burs and Changes in the Cutting Edge Carbide Burs. Journal of Dentomaxillofacial Radiology, Pathology and Surgery. 2018; 7(2):77-84.

doi: http://dx.doi.org/10.32598/3dj.7.2.77



**Funding:** See Page

**Article info:**
**Received:** 10 Dec 2017
**Accepted:** 28 Mar 2018
**Available Online:** 01 Jun 2018

**Keywords:**
Dental burs, Sterilization, Diamond, Carbide, Dentistry

## ABSTRACT

**Introduction:** Dental burs are among the most commonly used instruments in dental offices and have the most possible cross-contamination risks. The sterilization of dental burs is highly noted and necessary. The present study evaluated the effects of different sterilization methods on the uniformity of diamond dental burs and changes in the cutting edge carbide burs.

**Materials and Methods:** In this descriptive study, to assess the results of sterilization, 36 burs (18 diamond burs and 18 carbide burs) were studied. In total, 18 diamond burs using R software were randomly divided into the 3 groups of 6 burs (dry-clave group, autoclave group, and cold sterilization group). Each group was divided into the 2 subgroups of 3 burs; the first subgroup received 5 cycles and the second subgroup received 15 cycles of sterilization. The same process was used for 18 carbide burs to categorize them into groups and subgroups. A pre-assessment was conducted by Scanning Electron Microscopy (SEM). After the sterilization cycles, a post-test SEM was performed. Adobe Photoshop 2017 was used in a gray scale of 12 to compare the pre-test and post-test differences. Kruskal-Wallis test, Analysis of Variance, Mann-Whitney U test, and Post Hoc Tukey test were used to analyze the obtained data in SPSS at a significance level of P=0.05.

**Results:** Dry-clave was the best approach in 5 cycles of sterilization for diamond and carbide burs. Moreover, autoclave was the best method for 5 cycles of sterilization (P<0.05). In 15 cycles of sterilization of diamond and carbide burs, the best method was auto-clave which exhibited a significant difference in carbide burs.

**Conclusion:** Dry-clave and autoclave were the most appropriate approaches for 5 and 15 cycles of sterilization of diamond burs, respectively. In sterilization of carbide, in both 5 and 15 cycles, autoclave was the best method. All of the sterilization methods caused corrosion, discoloration, and the loss of integrity in carbide burs; however, these changes were minimum in the autoclave method. In conclusion, auto-clave method is recommended due to causing the least changes in carbide and diamond burs.

*** Corresponding Author:**
***Dina Maleki, Dentistry Student***
***Address:*** *Student Research Committee, Dental Research Center, Faculty of Dentistry, Guilan University of Medical Sciences, Rasht, Iran.*
***Tel:*** *+98 (912) 8998663*
***E-mail:*** *dinamaleki74@gmail.com*

Journal of Dentomaxillofacial Radiology, Pathology and Surgery

## 1. Introduction

Infection control has gained major attention in healthcare systems. Dentistry treatment is widely exposed to blood and saliva; thus, infection control is crucial to protect dentists, patients, and technicians. An organized protocol for obtaining a thorough diagnosis must be followed medical history [1, 2]. Destroying or deactivating all microorganisms, especially resistant bacterial spores by autoclave, dry heat, hydrogen peroxide gas, and chemicals is defined as sterilization [3]. Disinfection consists of rendering harmless pathogens by heat, UV, ultrasound, antiseptics, antibacterial agents, and so on [4]. The type of microorganisms, the degree of contamination and the type of instruments determine whether to sterilize or disinfect those. Wet techniques decrease the lifetime of instruments by causing corrosion; dry techniques require more time to sterilize instruments leading to the dullness of sharp instruments [1-6].

Bae et al. evaluated changes in the cutting edge of different dental diamond rotary instruments after repeated cuts and repeated disinfection procedure. They concluded that the cutting efficiencies of instruments decreased after repeated cuts; however there were no changes after performing various disinfecting procedures [7].

Porto et al. studied the effect of repeated sterilization cycles on the physical properties of scaling instruments. They reported stainless steel curettes went through mild alterations with sterilization; whereas carbon steel curettes were visibly affected by sterilization in the autoclave. However, when the inhibition of corrosion was used prior to the sterilization, the oxidation was considerably reduced [8].

Dental burs are the most commonly used instruments in dentistry. Thus, the infection will most probably be transmitted from patients to their dentist or among patients. Therefore, sterilization methods are of great importance. The effect of sterilization method on the surface and structural properties of burs are very important. The present study investigated the effects of three methods of sterilization on diamond and carbide burs.

## 2. Materials and Methods

In this descriptive study, 18 carbide burs and 18 diamond burs (with 10 mm shank and 0.8 mm diameter, moderate roughness, medium size) were prepared (Teeskavan Co.). A groove was created on the shank of all burs so that the images were taken from the same aspect of burs before and after sterilization. Using Scanning Electron Microscopy (SEM) (Philips xl30), initial images were taken. Then, 18 diamond burs were divided into the 3 groups of 6 burs (cold sterilization/autoclave/dry-clave). Each group was divided into the 2 subgroups of 3 burs; the first subgroup received 5 cycles and the second subgroup received 15 sterilization cycles. The other 18 carbide burs were categorized into groups and subgroups by the same process.

For cold sterilization, burs were placed in separate coded containers; then, the containers were filled in with 2% glutaraldehyde. Burs were maintained in the solution for 8 hours at room temperature. Then, they were rinsed using ultrasound and distilled water for 10 minutes. This procedure was repeated with a fresh solution for 5 cycles in the first subgroup and 15 cycles in the second subgroup.

In the dry-clave method, burs were placed in containers, then into the oven (170°C) for 1 hour. Chemical indicators were used in each container to assure the completion of sterilization procedure. The procedure was repeated 5 and 15 times, respectively in the first and second subgroups with new chemical indicators for each cycle.

In the steam method, the samples were packed and placed in autoclave for 15 minutes (pressure:15 psi, temperature: 121°C). Chemical indicators were used on packages to assure the completion of sterilization procedure. The procedure was repeated for 5 times in the first group and 15 times in the second group using new chemical indicators for each cycle.

Then, the final images were captured. Adobe Photoshop 2017 was used in a gray scale of 12. It compared the images before and after sterilization to evaluate the color change of carbide burs resulting from corrosion. Diamond particle was counted in the square of 2500 $\mu m^2$ before and after sterilization to evaluate diamond burs. Kruskal-Wallis test, Analysis of Variance (ANOVA), Mann-Whitney U test, and Post Hoc Tukey test were used to analyse data in SPSS.

## 3. Results

The current study compared the efficacy of 3 different methods of sterilization on 18 diamond burs and 18 carbide burs. The obtained results are presented in Tables 1, 2, and 3. The color change in carbide burs (5 cycles-15 cycles) were significant at pre- and post-test phases, based on Kruskal-Wallis test (P=0.018) and Mann-Whitney U test in a pairwise comparison of the groups (P=0.025). However, there was no significant change between the 3

**Table 1.** The effect of autoclave on the particle size of diamond burs and color change of carbide burs

| Burs | 5 Cycles (Mean±SD) | P | 15 Cycles (Mean±SD) | P |
|---|---|---|---|---|
| Diamond burs | 1.67±0.58 | 0.125 | 3.33±0.58 | 0.125 |
| Carbide burs | 1.00±00 | 0.018 | 2.00±00 | 0.018 |

**Table 2.** The effect of dry-clave on the particle size of diamond burs and color change of carbide burs

| Burs | 5 Cycles (Mean±SD) | P | 15 Cycles (Mean±SD) | P |
|---|---|---|---|---|
| Diamond burs | 0.67±0.58 | 0.125 | 4.67±2.08 | 0.125 |
| Carbide burs | 2.00±00 | 0.018 | 3.00±00 | 0.018 |

**Table 3.** The effect of cold sterilization on the particle size of diamond burs and color change of carbide burs

| Burs | 5 Cycles (Mean±SD) | P | 15 Cycles (Mean±SD) | P |
|---|---|---|---|---|
| Diamond burs | 1.67±0.58 | 0.125 | 3.67±1.15 | 0.125 |
| Carbide burs | 3.00±00 | 0.018 | 5.00±00 | 0.018 |

studied groups in the particles of diamond burs at pre- and post-test phases, according to ANOVA results (P=0.125); and based on the Post Hoc Tukey test in a pairwise comparison of groups (Figures 1, 2, 3, and 4).

## 4. Discussion

The current descriptive study aimed to compare the efficacy of 3 different methods of sterilization on 18 diamond burs and 18 carbide burs after the 5 and 15 cycles of sterilization. In the sterilization of carbide burs, the best method, in both the 5-cycle and the 15-cycle of sterilization was the autoclave. In the sterilization of diamond burs in 5 cycles, the best approach was dry-clave

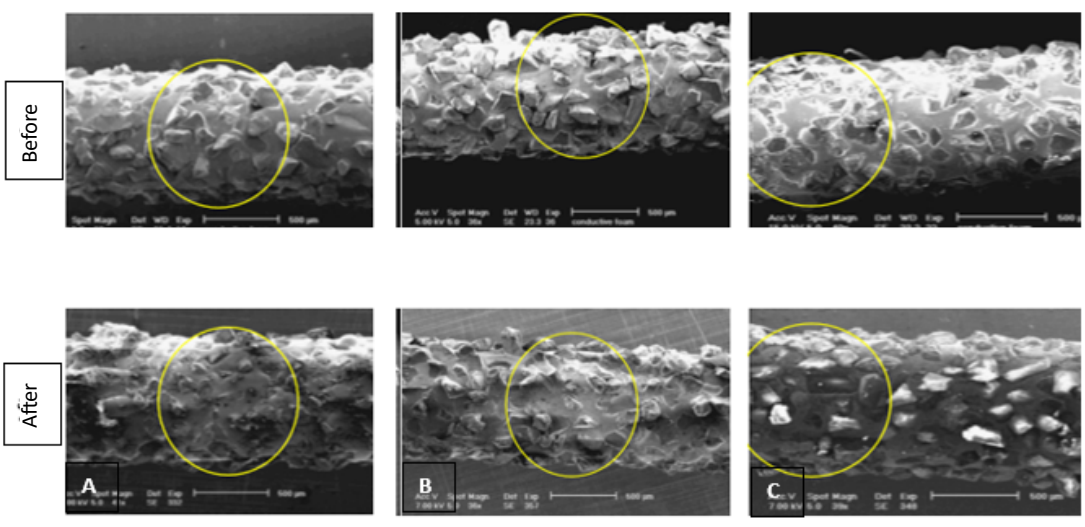


**Figure 1.** Diamond burs before and after the 5 cycles of sterilization

A: Cold clave; B: Dry-clave; C: Autoclave

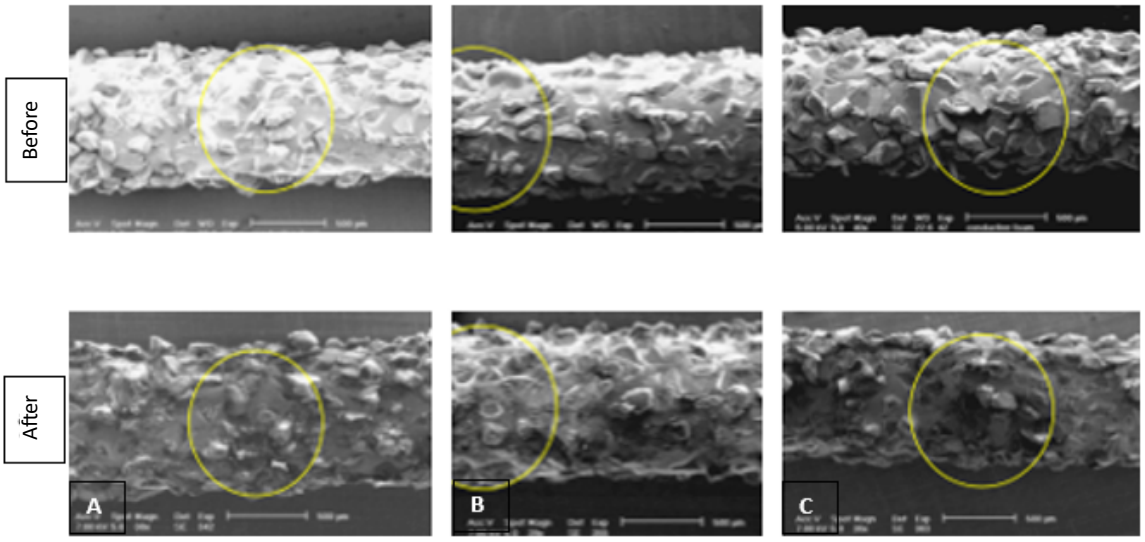


**Figure 2.** Diamond burs before and after the 15 cycles of sterilization

A: Cold clave; B: Dry-clave; C: Autoclave

method and in 15 cycles, autoclave was the method of choice. In total, the least changes in the sterilization of carbide and diamond burs were observed in the autoclave method.

It is suggested that the autoclave method be used for the sterilization of carbide and diamond burs. In the evaluation of carbide burs with electron microscopy, color changes due to corrosion on the surface of burs, and the uniformity and integrity of cutting edge in the cold sterilization method were observed. In the dry-clave method, the same changes were observed; however, the cutting edges and color changes were less than the previous method. In the autoclave method, only color changes due to corrosion were observed on the surface of burs.

Accordimg to McLundie et al. burs floated in chemical solutions demonstrated different degrees of corrosion along with the burs [9]; however, they clearly showed lower degradation in the cutting edges. A possible explanation for this finding is that glutaraldehyde leads to a macroscopic galvanic reaction between the different sec-

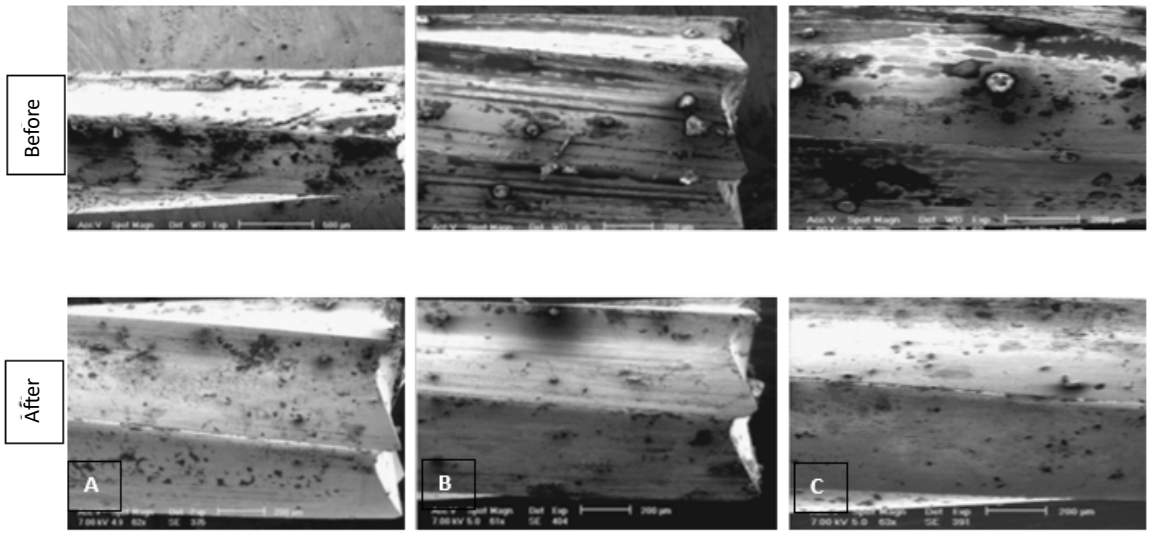


**Figure 3.** Carbide burs before and after the 5 cycles of sterilization

A: Cold clave; B: Dry-clave; C: Autoclave

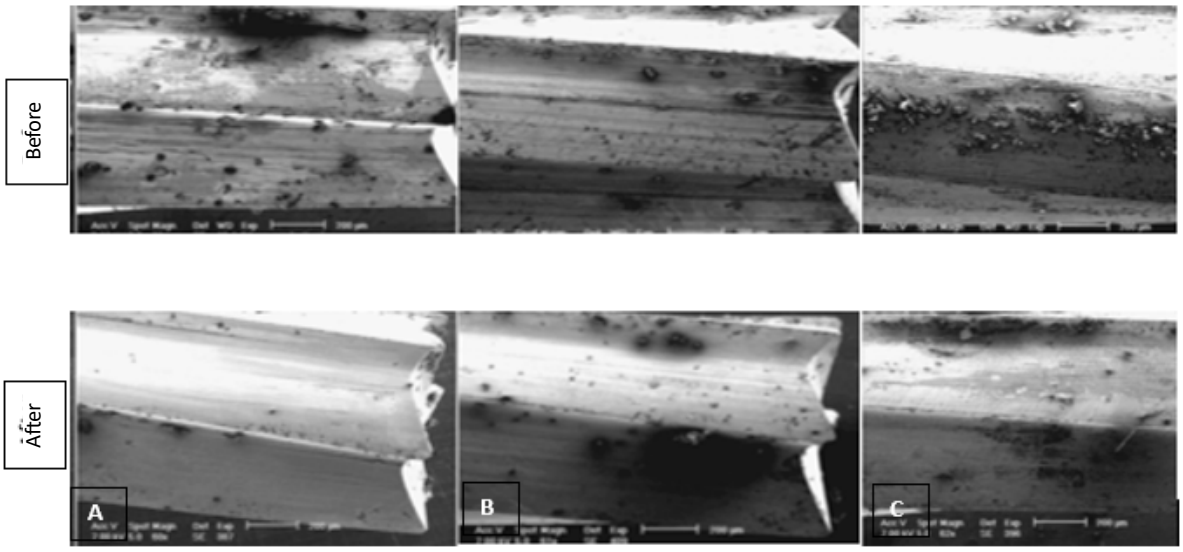


**Figure 4.** Carbide burs before and after the 15 cycles of sterilization

A: Cold clave; B: Dry-clave; C: Autoclave

tions of bur and solvent. Júnior et al. recognized glutaraldehyde as the worst method of sterilization of carbide instruments which decreases their lifetime [10]. Assessing SEM images of diamond burs revealed that cold sterilization reduced the number of particles per surface, and slightly changed the color of surface of burs. Gureckis et al. and Villasenor et al. found that chemical sterilizers reduced diamond particles [11, 12].

Bapana et al. argued that the sterilization of metal instruments by chemical sterilizers caused significant corrosion [13]. Nael et al. stated that the corrosion resulting form cold sterilization is unavoidable [14].

All of these studies are consistent with the obtained results of this study. We observed the greatest changes in carbide burs and diamond burs when cold sterilization with glutaraldehyde was used; where the corrosion of cutting edge was clearly visible in the SEM images. In contrast, Bae et al. stated that sterilization with cold, ethylene oxide gas and autoclave methods do not affect the cutting rate [7]. This can be explained by the difference in disinfection solutions used in the studies. They used 5% chlorhexidine gluconate which is an acidic solution (pH=5.5-7.0); while the present study used 2% glutaraldehyde (pH=7.5-8.5) which is an alkanoic solution.

Dry-clave of carbide burs changes their color and corrosion. With a larger magnification of the SEM images, it was detected that corrosion caused by dry-clave method was lower, compared to the cold method. This may be explained by the fact that the dry sterilization process is used to degrade the microorganisms, which also occurs in a dry environment. The environment maintains stainless steel integrity and improves fracture resistance in different burs. Dry-clave method was the best approach when the diamond burs were sterilized for 5 cycles. However, the method decreases the size and numbers of diamond particles and changes the color when repeated for 15 cycles. Gureckis et al. reported the same findings [11].

The method of choice for the 15 cycles of sterilization of carbide and diamond burs were autoclave. The findings are in agreement with the study of Laza Maria et al. [15]. They reported that autoclave sterilization caused no changes in the cutting edge of burs.

However, Siegel et al. and Savage et al. found that autoclave and sterilization lead to the corrosion of burs which is due to the type of adhesion of diamond grit to the metal rod [16, 17]. Boldieri et al. stated that in 9 cycles of sterilization, burs which were sterilized using autoclave, lost more diamond particles, compared to burs sterilized in the oven [18]. Their findings are in-line with the current study in terms of recognizing dry-clave as the method of choice in 5 cycles. However, they are different from the current study findings in 15 cycles of sterilization in respect of stating autoclave to be of benefit. In the lower cycles of sterilization, dry-clave is more beneficial; however, but with more repeated cycles, autoclave is preferred over dry-clave method.

Burs used in the current study were manufactured using galvanic deposition. The materials used to manufacture burs may be thermal resistance. This hypothesis can

explain the reason why dry clave is the method of choice in 5 or 9 cycles. By repeating the cycles of sterilization, the thermal resistance materials will be denaturized and the burs will be more sensitive to heat. This can explain why autoclave is better than dry-clave method in more repeated cycles. Additionally, Boldieri et al. evaluated the cutting efficacy of burs using a precision scale, while we used SEM imaging after creating a groove on the shank of burs to take images from the same aspect [18].

The small number of burs were a limitation to this study. Further studies are suggested to use more burs with different roughness grades and different methods of sterilization.

## 5. Conclusion

The autoclave was the best method of sterilization (5 cycles-15 cycles) for carbide burs; dry-clave and autoclave were the best methods of sterilization respectivley, for 5 cycles and 15 cycles of the sterilization of diamond burs.

Also as an option the digital workflow eliminates disinfection of the impressions and transmission of blood and saliva to technician [19].

## Ethical Considerations

### Compliance with ethical guidelines

This study was an in vitro study on dental burs. There was no ethical considerations to be considered in this research.

### Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### Authors' contributions

Conceptualization, Methodology, Supervision: Ilnaz Pournasiri, Hamid Neshandar Asli; Investigation, Writing-original draft, Writing-review and editing: Ilnaz Pournasiri, Hamid Neshandar Asli, Reza Abbaspour, Dina Maleki; Visualization: Ilnaz Pournasiri, Reza Abbaspour, Dina Maleki; and Funding acquisition: Ilnaz Pournasiri, Hamid Neshandar Asli, Reza Abbaspour.

### Conflict of interest

The authors declared no conflict of interest.

## References

[1] Moradi Khanghahi B, Jamali Z, Pournaghi Azar F, Naghavi Behzad M, Azami-Aghdash S. Knowledge, attitude, practice, and status of infection control among Iranian dentists and dental students: A systematic review. Journal of Dental Research, Dental Clinics, Dental Prospects. 2013; 7(2):55-60. [DOI: 10.5681/joddd.2013.010] [PMCID] [PMID]

[2] Geramipanah F, Sadighpour L, Hendi A. Management of limited interocclusal distance with the aid of a modified surgical guide: A clinical report. Journal of Dentistry. 2017; 14(2):105-8. [PMID] [PMCID]

[3] Asad S, Awaisi Zh, Bokhari F. A Survey on cross infection hazards associated with dental impression recording. Pakistan Oral & Dental Journal. 2012; 32(2):284-52.

[4] Haralur SB, Al-Dowah OS, Gana NS, Al-Hytham A. Effect of alginate chemical disinfection on bacterial count over gypsum cast. The Journal of Advanced Prosthodontics. 2012; 4(2):84-8. [DOI:10.4047/jap.2012.4.2.84]

[5] Amirzade-Iranaq MH, Khosravi MH. Infection control status in dental practice: Why to take it serious. International Journal of Medical Reviews. 2017; 4(1):1-2 [DOI:10.29252/ijmr-040101]

[6] Ghimire B, Chandra S. Awareness of infection control among dental students and interns. Journal of the Nepal Medical Association. 2018; 56(210):598-601. [DOI:10.31729/jnma.3582]

[7] Bae JH, Yi J, Kim S, Shim JS, Lee KW. Changes in the cutting efficiency of different types of dental diamond rotary instrument with repeated cuts and disinfection. The Journal of Prosthetic Dentistry. 2014; 111(1):64-70. [DOI:10.1016/j.prosdent.2013.07.002]

[8] Porto AN, Borges ÁH, Semenoff-Segundo A, Raslan SA, Pedro FL, Jorge AO, et al. Effect of repeated sterilization cycles on the physical properties of scaling instruments: A scanning electron microscopy study. Journal of International Oral Health. 2015; 7(5):1-4. [PMCID] [PMID]

[9] McLundie AC. The effects of various methods of sterilization and disinfection on tungsten-carbide burs. British Dental Journal. 1974; 37(2):49-55. [DOI:10.1038/sj.bdj.4803238]

[10] Júnior PCS, Soares CJ, Rodrigues RB, Veríssimo C, Dutra MC, Quagliatto PS, et al. Comparison of different wear burs after cavity preparation and sterilization methods. Revista Odontológica do Brasil Central. 2012; 21(59):547-52.

[11] Gureckis KM, Burgess O. Cutting effectiveness of diamond instruments subjected to cyclic sterilization methods. Journal of Prosthetic Dentistry. 1991; 66(6):721-6. [DOI:10.1016/0022-3913(91)90402-I]

[12] Villasenor A, Hill SD. Comparison of two ultrasonic cleaning units for deterioration of cutting edges and debris removal on dental burs. Pediatric Dentistry. 1992; 14(5):326-30. [PMID]

[13] Bapana MS, Mueller HJ. Corrosion of dental burs in sterlizing and disinfecting solutions. Journal of Prosthetic Dentistry. 1988; 55(9):502-11. [DOI:10.1016/0022-3913(88)90051-0]

[14] Neal RG, Craig RG, Powers JM. Effect of sterilization and irrigants on the cutting ability of stainless steel files. Journal of Endodontics. 1983; 9(3):93-6 [DOI:10.1016/S0099-2399(83)80104-6]

[15] Fais LM, Pinelli LA, Adabo GL, Silva RH, Marcelo CC, Guaglianoni DG. Influence of microwave sterilization on the cutting capacity of carbide burs. Journal of Applied Oral Science. 2009;17(6):584-9 [DOI:10.1590/S1678-77572009000600009] [PMCID] [PMID]

[16] Siegel SC, Von Fraunhofer JA. Dental cutting: The historical development of diamond burs. Journal of the American Dental Association. 1998; 129(6):740-5. [DOI:10.14219/jada.archive.1998.0316]

[17] Savage NW, Walsh LJ. The use of auto-claves in the dental surgery. Australian Dental Journal. 1995; 40(3):197-200. [DOI:10.1111/j.1834-7819.1995.tb05637.x]

[18] Boldieri T, Busnelli DG, Cardoso JA, Josgrilberg EB, Coedeiro RCL. Influence of sterilization process on cutting effectiveness and durability of ultrasonic tips. Brazilian Dental Science. 2015; 18(3):10-16. [DOI:10.14295/bds.2015.v18i3.1143]

[19] Hendi AR, Moharrami M, Siadat H, Hajmiragha H, Alikhasi M. The effect of conventional, half-digital, and full-digital fabrication techniques on the retention and apical gap of post and core restorations. The Journal of Prosthetic Dentistry. 2019; 121(2):364-e1. [DOI:10.1016/j.prosdent.2018.09.014]

This Page Intentionally Left Blank