Comparison of different wear burs after cavity preparation and sterilization methods

Comparação do desgaste de diferentes pontas após preparo cavitário e diferentes métodos de esterilização

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RESUMO

Objetivo: Avaliar a perda estrutural e alteração morfológica da superfície de diferentes instrumentos de corte após preparo cavitário e diferentes métodos de esterilização. Material e Método: Cavidades padronizadas na superfície vestibular de incisivos bovinos foram realizadas na região do limite cemento-esmalte usando cinco diferentes tipos de instrumentos de corte (n= 4): Ca- broca cilíndrica Carbide #56 (KG Sorensen), Kg- ponta diamantada cilíndrica #1093 (KG Sorensen), Mi- ponta diamantada cilíndrica #1093 (Microdont), Fa- ponta diamantada cilíndrica #1093 (Fava) e Cv- ponta diamantada cilíndrica artificial #8,2137 (CVDentUS). Cada ponta foi submetida a um ciclo que envolveu a realização de microscopia eletrônica de varredura (MEV) inicial, preparo cavitário (PC), limpeza com ultrassom (US), três métodos de esterilização: glutaraldeído a 2% (Gl), estufa - calor seco (DH) ou autoclave – calor úmido (WH), e MEV final. Resultados: Foram encontradas diferenças significativas para a interação entre os fatores. Conclusão: O método de esterilização modifica estruturalmente os instrumentos de corte de modo diferente entre os tipos de instrumentos testados. O glutaraldeído foi o método que apresentou pior resultado para as brocas carbides. As pontas diamantadas apresentaram grande variabilidade de resultados para a interação dos fatores desgaste de instrumentos de corte e processos de esterilização.

PALAVRAS-CHAVE: Brocas; Preparo Cavitário; Esterilização; Microscopia Eletrônica de Varredura.

INTRODUCTION

Over the years, dentistry has benefited from technological evolutions and research that led to several development and improvement of new materials and tools.[1] The first burs were manufactured from steel and later from tungsten carbide, but the primary dental instrument for fixed restorative dentistry is the diamond bur, which was introduced in the late 19th century[2, 3]. However, the diamond burs have limitations as: heterogeneity of the diamond particles shape, difficulty in manufacturing, reducing the effectiveness of cut caused by repeated sterilization and low longevity[4, 5].

The complex structure of cutting instruments may retain debris over the surface, which directly affects the efficiency of cut and can still serve as a means of cross contamination and diseases transmission[9, 10]. Although, the use of disposable cutting instruments should be encouraged as a preventive strategy of performance and appropriate infection control[11], in dentistry practice is common the reuse of instruments. [12] Nevertheless, for the reuse these instruments, reliably, is essential carry out proper cleaning and sterilization thereof[13-16]. but studies show that cleaning performed on the instruments is not always efficient[17, 18].

The cleaning procedure is a meticulous technique and requires attention to detail. Studies reveal a high rate of bacterial contamination of cutting instruments and that association of more than one method is effective in debris removing[12-14, 19-21]. The aggressiveness of the disinfection solutions and sterilization process may affect the performance of the instruments, because the structural degradation reduces the longevity and efficiency of the cutting instruments[4, 22]. The use of inadequate cutting instruments can generate heat and vibration on enamel and dentine, and may result in pulp injuries[23, 24], and higher restoration leakage[25].

Therefore, the purpose of this study was to evaluate the loss structural and morphological changes of different cutting instruments after cavities preparations and different methods of sterilization. The hypothesis tested was that after use and sterilization methods of the cutting instruments they would change structure, reducing its cutting efficiency.

MATERIAL AND METHOD

Five different types of cutting instruments were evaluated (n = 4): Ca, cylindrical carbide bur #56 (KG Sorensen, Barueri, SP, Brazil); Kg, cylindrical diamond bur #1093 (KG Sorensen, Barueri, SP, Brazil); Mi, cylindrical diamond bur #1093 (Microdont, São Paulo, SP, Brazil); Fa, cylindrical diamond bur # 1093

(Fava, São Paulo, SP, Brazil); and Cv, cylindrical diamond bur # 8.2137 (CVDentus, São Paulo, SP, Brazil).

The cutting instruments were removed from casings and observed in scanning electron microscopy – SEM (LEO 435 VP, LEO Electron Microscopy, Cambridge, UK) - SEM initial (Figure 1). Samples from each group were randomly subdivided into four subgroups according to the processes of sterilization: US - ultrasonic cleaner for 05 minutes with acetone; Gl - 2% Glutaraldehyde (Glutaron II, São Paulo, SP, Brazil), stored in plastic bottle for 10 hours; DH – dry heat in stainless steel boxes for 60 minutes at a temperature of 170ºC; WH – wet heat for 30 minutes at 121ºC at a pressure of 1 atmosphere, and the samples were wrapped with surgical grade paper. All samples were ultrasonically cleaned prior to sterilization processes with acetone

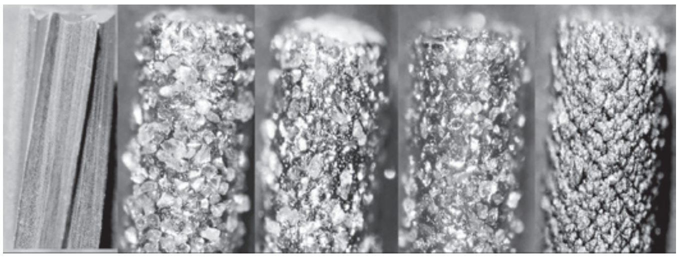

Figure 1. Initial image taken with stereoscopic magnifying glass (40X) of a sample of the GI, GII, GIII, GIV and GV, respectively.

for five minutes and placed on absorbent paper, due to its high volatility and reduced drying time.

Cavity preparation

One hundred recently extracted bovine incisors with similar dimensions were selected and stored in aqueous 0.2% thymol solution (F.Maia Ind. Com., Cotia, SP, Brazil). Calculus deposits and soft tissue were removed with periodontal curettes (Hu Friedy, Chicago, IL, USA); then, the teeth were cleaned using a rubber cup (Microdont, São Paulo, SP, Brazil) and fine pumice (Vigodent, RJ, Brazil) water slurry. Five teeth were distributed between the groups for cavity preparation. The root portion of each tooth was sectioned 2.0 mm from cemento-enamel junction (CEJ), using a diamond double-faced disk (KG Sorensen, Barueri, SP, Brazil) in a slow-speed handpiece, cooled with air/water spray. The pulp was removed with endodontic files. The teeth were mounted individually in plastic cylinders (Tigre, Rio Claro, SP, Brazil) and were embedded in polystyrene resin (Cristal, Piracicaba, SP, Brazil) for cavity preparation.

The preparations were done by a single operator, ensuring greater uniformity of force application and handling of equipment. Cavities were prepared with boundary in cemento-enamel junction. The preparations was standardized with the use of a Teflon mold with central hole with 5 mm, 6 mm in length and 2 mm deep, then conferred with the aid a digital caliper (S235, Sylvac, Switzerland).

To carry out the cavities, it is used the instruments listed above. The diamond and carbide burs were used in high-speed turbine-Flex Dent 380.000 to 420.000 rpm (Futura 2, Ribeirão Preto, SP, Brazil) and CVDentus engaged in ultrasound (Gnatus, Jet. Sonic, Ribeirão Preto, SP, Brazil) at a frequency of 29 kHz using 60% of power, as recommended by the manufacturer.

Analysis of samples

For each sample were performed: Scanning Electron Microscopy (SEM) initial, cavity preparation (PC), clean-up ultrasonic (US), sterilization (S), and final SEM. The images taken in a scanning electron microscopy were analyzed by three evaluators according to the criteria shown in Table 1.

The evaluators were calibrated, and in the analysis on which there were differences of opinion, the evaluators discussed among themselves and there was a consensus, so that only one criterion was chosen to analyze and classify each method of sterilization.

Table 1. Criteria used by the evaluators to analyze the SEM images after sterilization

Criterias	Carbide Bur	Diamond instruments
0	Absence of morphological alterations of the cutting instrument	No change in the structural diamond instrument
1	Staining in the surface of the instrument	Small diamond loss
2	Staining the surface of the instrument and loss of blade integrity	Large diamond loss

RESULTS

The table 2 showed the analysis performed by three evaluators for the criteria evaluated (cutting instruments and sterilization methods) by Scanning Electron Microscopy.

Table 2. Results of the analysis of the three evaluators by Scanning Electron Microscopy, considering the criteria presented.

CRITERIA	Ca				Kg				Mi			
	US	DH	GL	WH	US	DH	GL	WH	US	DH	GL	WH
0									X	X		
1	X	X		X							X	X
2			X		X	X	X	X				

CRITERIA	Fa				Cv			
	US	DH	GL	WH	US	DH	GL	WH
0								
1	X	X	X	X		X		
2					X		X	X

In the group Ca, it was observed that when subjected to sterilization by wet heat or dry heat, carbides burs showed only staining in the surface of the instrument to undergo a slight corrosion (Figure 2). When subjected to the sterilization with glutaraldehyde it was observed staining in the surface of the instrument and loss of integrity of the cutting blades.

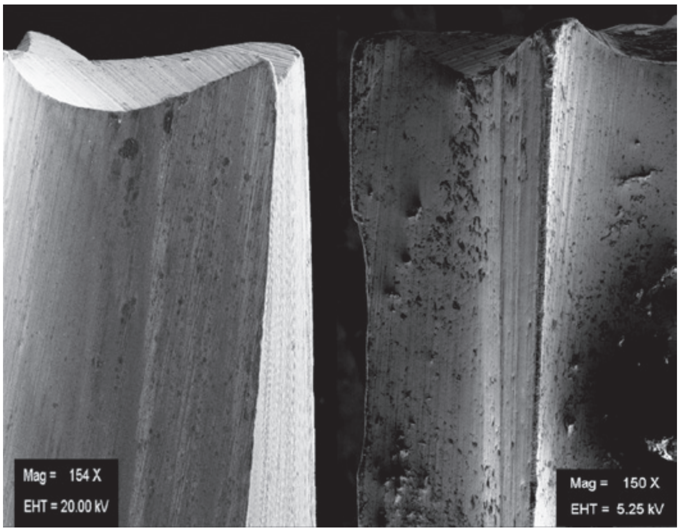

Figure 2. Initial and final SEM of GI submitted to the dry heat sterilization method.

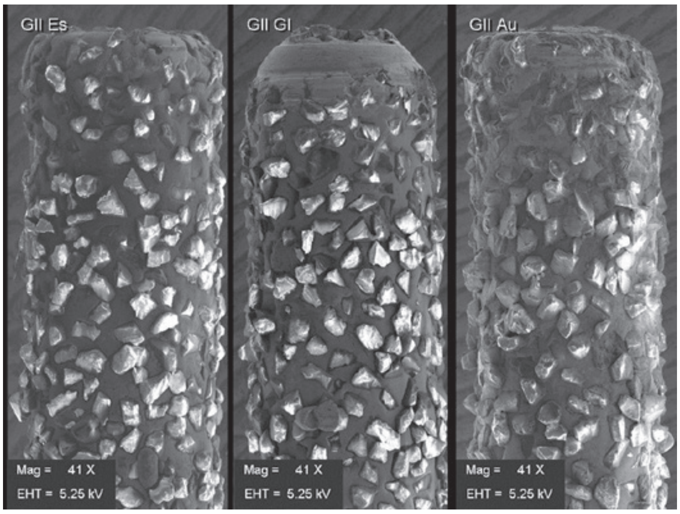

Figure 3. Final SEM of samples of Group II i submitted to the dry heat sterilization method, glutaraldehyde and autoclave, respectively (Magnification: 41x).

Figure 4. Initial and final SEM of a sample of group III (Magnification: 155 X).

The groups Kg, Mi and Fa consisting of diamond instruments of similar size, but of different manufacturers showed great variation with respect to wear suffered with reference to different sterilization methods. As the classification of images showed large variation, since there has been no standardization of a method to alter more or less the surface of instrument (figures 3, 4 and 5).

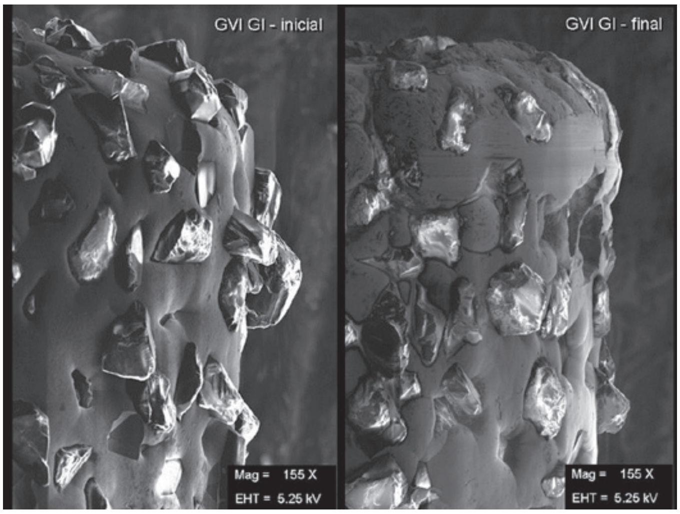

Figure 5. Initial and final SEM of GIV sterilized in glutaraldehyde (Magnification: 155 X).

The sterilization in autoclave (wet heat) for group Cv was the method that generated greater structural and morphological changes and large diamond loss (figure 6), but sterilization in glutaraldehyde and cleaning with ultrasound also resulted in large diamond loss.

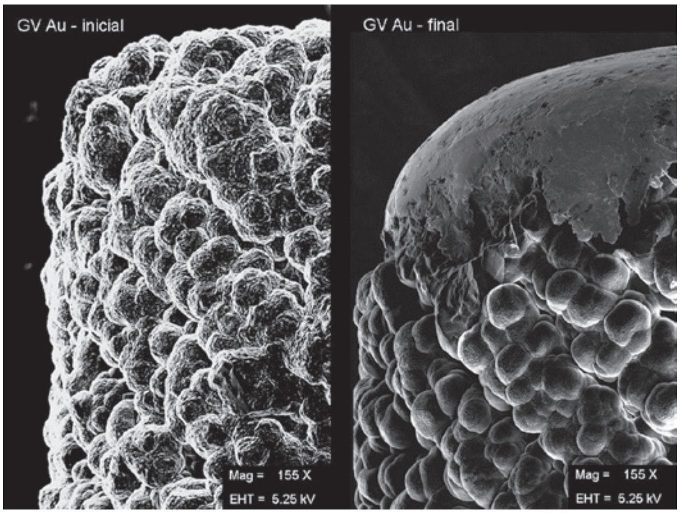

Figure 6. Initial and final SEM of GV sterilized in autoclave (Magnification: 155 X).

DISCUSSION

The hypothesis of this study was acceptable, after cavity preparations and sterilization methods the cutting instruments showed different structural changes among the types of instruments tested, possibly changing its cutting efficiency.

The sterilization process and cutting efficiency is negatively influenced by tissue fragments, dental restorative materials, saliva, blood products, and microorganisms that tend to compact on the structure these cutting instruments[18, 26], need to always perform a thorough cleaning. The cleaning procedures that are used include mechanical (different kinds of brushes and sponges) and chemical cleaning (immersion in sodium hypochlorite, detergents or enzymatic cleaners), ultrasound and a final rinse before sterilization[10, 14, 16, 27, 28]. The use of ultrasound prior to all sterilization procedures was recommended with the aim to remove debris that could be attached to the active tip of the cutting burs after cavity preparation. And according to SEM images of the instruments, the use of ultrasound appeared to be effective in cleaning regardless of the type of instrument rated, in accordance with previous study[11, 16].

Carbide burs are massive, high-strength steel, with angled cutting blades arranged regularly, promoting a high standard of material removal[1]. Therefore, the process of wear occurs from these blades present, and that, if damaged, hindering the cutting of tooth structure. The evaluation of carbides burs showed that cleaning ultrasson did not alter the surface morphology, and was similar those found in wet heat and dry heat. This shows that these two methods are effective for sterilization and maintains the integrity of the cutting blades of the burs, since it was observed only a color change that characterizes a possible corrosion[29]. Already the method of sterilization with glutaraldehyde should not be used for these burs, since it was observed staining in the surface of the instrument and loss of integrity of the cutting blades. By consensus this study showed that sterilization without humidity is the best method to be used in carbide drills, since it induces a lower instrument variation in morphological and structural level.

The diamond instruments are capable of abrasion by means of diamond grains with sharp edges of its surface[30]. The particle size variation permits more cutting capacity by creating a larger number of cutting edges[31]. The sterilization process probably influence the metal matrix that acts as bonding agent to keep the diamond grains on the stem, since that the properties of diamonds are raised to suffer no change[22]. The metal matrix is susceptible to corrosion and changes in the molecular layer of the bonding agent that makes it more fragile to resist the spread of tension during the function, leading to the formation of craters on its surface by the loss of diamond grains, which prevents further use[22].

No significant difference in the methods of sterilization of diamond instruments was observed in Kg, Mi and Fa. The microscopy these instruments did not show standardization of changes caused by different methods of sterilization. This happened, possibly due to the heterogeneity of the shape and number of diamond grains, differences in average grain spacing by the difficulty in manufacturing automation and changes caused by each sterilization method, although belonging to the same manufacturing batch[4,5].

Diamond burs subjected to the sterilization process in a dry environment for 170ºC/ 60 minutes and cooled to room temperature, leads to hardening of the layer of nickel present in the metal matrix of these burs and when placed in clinical function there is a concentration of tension between the diamond grains and matrix metal to the coalescence breakup. Thus, the instrument loses its diamond grains and going to be inefficient[22].

The CVD diamond bur, valued in the group Cv, is produced by depositing a diamond film on the substrate of the rod, which is cooling after its unique structure formation of diamond[32]. This makes these burs are more resistant to wear[4], its structure is not changed after repeated sterilization[8]. In this study, autoclaving for CVD diamond bur led to greater structural and morphological changes. This can occur because in autoclave at 121°C for thirty minutes and saturated atmosphere with water vapor, it opens a passage between the diamond layer and the substrate due to differences in their thermal and mechanical properties[33], allowing the infiltration of water vapor. After cooling, the water vapor condenses in the region due to differences in coefficients of thermal expansion (ά) between the diamond and the substrate (usually molybdenum). When placed in function, are generated tensions in the interface between the substrate and diamond film, resulting in loss of adhesion of the diamond[22].

Thereby, since the introduction of cutting instruments, there was great concern of researchers to evaluate the cutting efficiency[34], its effects on tooth structure, resistance to wear of the instruments[35] and contamination of the teeth by bur constituents[36]. Nevertheless, the variability and lack of standardization with respect to these instruments prevents the determination of a universal sterilization protocol for all types of cutting instruments. But, the use of protocol involving combination of methods seems to provide more effective cleaning.

Sterilization methods and repeated use alter structurally the cutting instruments. Therefore, these instruments should be single-use; even thought financial considerations may inhibit the general acceptance of this practice. Hence the need for more knowledge on the part of the dentist and dental technician on the effect of each sterilization process performance of cutting instruments, seeking to obtain a safe procedure coupled with lower structural damage.

CONCLUSION

In the limitations of this study and based on the followed methodology, it can be concluded that:

- Sterilization methods affect structurally the cutting instruments;
- The methods of sterilization influence differently the types of instruments tested;
- Glutaraldehyde proved to be the worst method for sterilizing carbide bur;
- The diamond instruments showed great variability of results for the interaction of wear of cutting instruments and sterilization processes.

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ABSTRACT

Objective: evaluate the loss of mass and the morphologic surface alteration of different cutting instruments after cavity preparation from dental structure and different methods of sterilization. Material and Method: standardized cavities in the buccal surface of bovine incisors had been carried through in the region of the limit enamel-cementum using five different types of cut instruments (n=4): Ca- cylinder carbide bur #56 (KG Sorensen), Kg- cylindrical diamond bur #1093 (KG Sorensen), Mi- cylindrical diamond bur #1093 (Microdont), Fa- cylindrical diamond bur #1093 (Fava) and Cv- cylindrical artificial diamond bur #8.2137 (CVDentUS). Each tip was submittes to a cycle that involved: Initial Scanning Electron Microscopy (SEM), cavity preparation (PC), clean-up ultrasonic (US), three methods of sterilization: glutaraldehyde 2% (Gl), dry heat (DH) or wet heat (WH) and final SEM. Results: significant difference for the interaction between factors was found. Conclusion: the sterilization method modifies structurally the cut instruments in different way among types of the instruments tested. Glutaraldehyde proved to be the worst method for sterilizing carbide bur. The diamond instruments showed great variability of results for the interaction of wear of cutting instruments and sterilization processes.

KEYWORDS: Burs; Cavity Preparation; Sterilization; Scanning Electronic Microscopy.

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