Drills physical changes after osteotomies and sterilization

https://doi.org/10.56238/sevened2024.006-016

Caroline Lemos Araújo Deveras Guimarães[1], Lívia Prates Soares[2], Andressa Ferreira Martins[3], Maylon Luciano Garcia Barbosa[4], Cristiano Góes de Andrade[5] and Antônio Márcio Teixeira Marchionni[6]

ABSTRACT

Some research suggest that the good condition of the drills used in osteotomies for dental implants is fundamental to a minimally invasive surgical technique, decreasing the temperature when preparing the surgical area. Objective: Analyze the wear of the drills used in osteotomies for dental implants, comparing the physical changes of the groups and types of coatings after their use, as well as evaluating the difference in these changes with and without sterilization. Ninety-six drills were used, 48 of which were spear-type (24 steel and 24 Diamond like carbon (DLC)) and 48 helical-type (24 steel and 24 DLC), divided into four groups: (G0), (G1), (G2) and (G3), with 0, 45, 90 and 135 osteotomies, with and without sterilization, evaluated by scanning electron microscopy (SEM). In this study, were used bovines ribs, with dimensions of 20cm in length, for osteotomies. Results: Wear of the drills after 90 osteotomies, p-value < 0.001; no evidence was found about the wear related to the sterilization process; and better performance of the steel twist drills in group G2 compared to the DLC twist drills in the same group, analyzed using the Mann-Whitney and Friedman statistical tests, as well as Dunn's post hoc test. Conclusion: Considering the wear and tear on the drills, their reuse is safe for up to 90 osteotomies.

Keywords: Dental Implants, Stainless Steel, Osteotomy, Sterilization.

---

[1] Graduated in Dentistry. UNIME University
[2] PhD in Oral and Maxillofacial Surgery and Traumatology. Pontifical Catholic University of Rio Grande do Sul - PUCRS
[3] Graduated in Dentistry. Paulista University
[4] Graduated in Dentistry. Faciplac College
[5] MSc in Implant Dentistry. Bahia School of Medicine and Public Health
[6] PhD in Dentistry. Bahia School of Medicine and Public Health

INTRODUCTION

The implantology is based on strong pillars, and in 2015, your consolidation will be 50 years, serving as a pivotal tool for oral rehabilitation. Studies conducted on dental instruments used in implants osteotomies describe the direct relationship between damages occurring in them and the increase in surgical trauma, resulting in increase the local heat above 47°C, and this heat is hardly dissipated due to physiological characteristics of the oral cavity bone, short bone with a considerable cortical layer, leading to an increase of tissue necrosis area due to the low thermal conductivity, resulting in greater local fibrosis and reduced initial implant stability (Barbosa, 2009; Carvalho et al., 2011; Chauhan et al., 2018; Eriksson et al., 1996; Iyer et al., 1997; Mendes et al., 2014; Santos et al., 2014; Sartori et al., 2012; Vasconcelos, 2012).

Considering the specific bone characteristics present in the oral cavity, the abundantly irrigate is essencial in all the surgical process of osteotomies, as it has been observed and proven that profuse irrigation tends to reduce the heat production, what is harmful to tissue healing process (Gehrke et al., 2013; Omar et al., 2023; Tur et al., 2020).

However, the research conducted by Santos et al. (2014) and Migliorati et al. (2013) found that even using the appropriate irrigation, the guided surgeries experience a higher temperature elevation during the osteotomies compared to the conventional surgeries. Researchers attribute this phenomenon of thermal elevation to the obstacle provided by the surgical guide, as well as to artifacts or instruments used during the procedure, even with sufficient irrigation.

Strbac et al. (2014a, b) emphasize that irrigation should be done from the tip of the drills, justifying that this is the best option for osteotomies with working lengths greater than 10mm.

Research by Scarano et al. (2011) revealed that another factor influences the increase in temperature during osteotomies, increasing the possibility of tissue necrosis. They point to the shape of the drills as this factor and state that conical-shaped drills promote lower milling temperatures when compared to cylindrical-shaped drills.

There is a consensus that increased tissue necrosis results in longer tissue repair time at the surgical site, and minimizing these negative effects also involves correct instrument maintenance. It is clear that the quality of dental instruments is of paramount importance when aiming for greater success in implant treatments (Bertolete, 2009; Comar, 2006; Cordioli et al., 1997; Junior et al., 2007; Matthews et al., 1972; Paterno et al., 2011; Junior et al., 2007). In this sense, the most frequent finding in the studies carried out is that the deformation of the drills is directly proportional to their use (Chauhan et al., 2018; Mendes et al., 2014; Santos et al., 2014; Sartori et al., 2012).

The coatings of dental drills used in dental implant surgery also interfere in this modification process, since depending on the material used in its composition, it will offer greater resistance to corrosion and deformation resulting from use (Ciuccio et al., 2010).

The aim of seeking high resistance in drills is to reduce wear by minimizing friction with adjacent tissues. Diamond-Like Carbon, commonly known by the acronym DLC, stands out in this universe of drill bit materials. This material has been widely used in medicine and dentistry due to its biocompatibility, hemocompatibility and lack of cytotoxicity (Dearnaley et al., 2005; Roy et al., 2007).

Attention is drawn to important assertions that have been widely discussed in studies on the subject: heating of the bone as a result of osteotomy procedures can lead to necrosis in the cortical area and/or affect the entire tissue region; the extent of necrosis varies according to factors such as irrigation and temperature control; and the repeated use of drills during preparation of the recipient site can increase wear, reducing drilling efficiency (Mendes et al., 2014; Santos et al., 2014; Sartori et al., 2012).

Another important point that deserves consideration, as it is commonly approached empirically, are the guidelines that underpin the surgeon's decision to replace the drills or surgical kit (Sharma et al., 2014), especially in relation to a number of uses greater than 100 times. It is necessary to understand the drill wear process in order to establish disposal parameters that minimize the deleterious effects of inappropriate reuse (Mishra et al., 2014) or the mistaken disposal of still viable instruments, which could increase treatment costs.

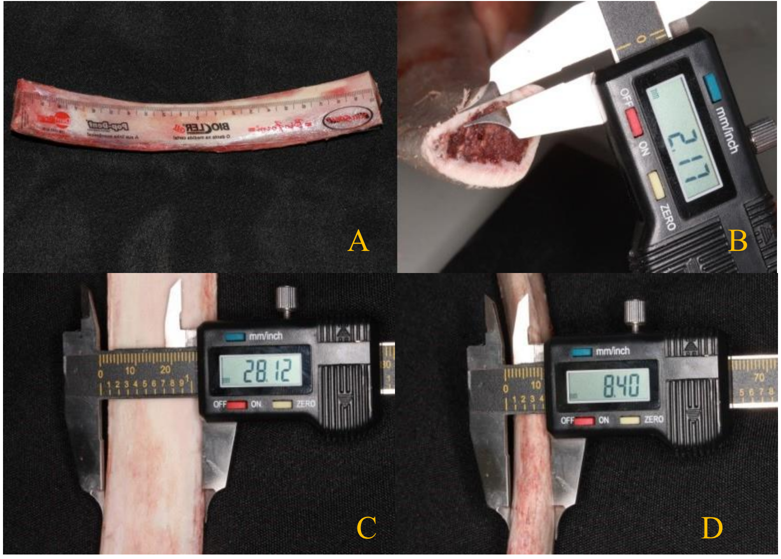
Therefore, in addition to researching the physical alterations of the drills due to use, an investigation was also carried out into the physical alterations of the drills when they were subjected to the cleaning and sterilization process. These reprocessing procedures are necessary to safeguard against biological contamination.

MATERIALS AND METHODS

STUDY DESIGN

This descriptive experimental study used bovine ribs obtained from a butcher's shop, from a previously slaughtered animal (Ercoli et al., 2004; Mendes et al., 2014; Queiroz et al., 2007; Sartori et al., 2012), where 65 units were selected based on the following inclusion criteria: length of at least 20 centimeters, at least 1 millimeter of cortical dimension surrounding the specimen, width over 27 millimeters and thickness greater than 8 millimeters (Figure 1). The measurements were taken using a digital caliper with a precision of 0.01mm (Model 500-144B - Mitutoyo - Brazil), and the ribs that did not meet the inclusion criteria were discarded.

Figure 1: A - Bovine rib 20.0mm; B- Cortical 1.0mm; C- Rib width; D- Rib thickness.



Source: Authors (2024)

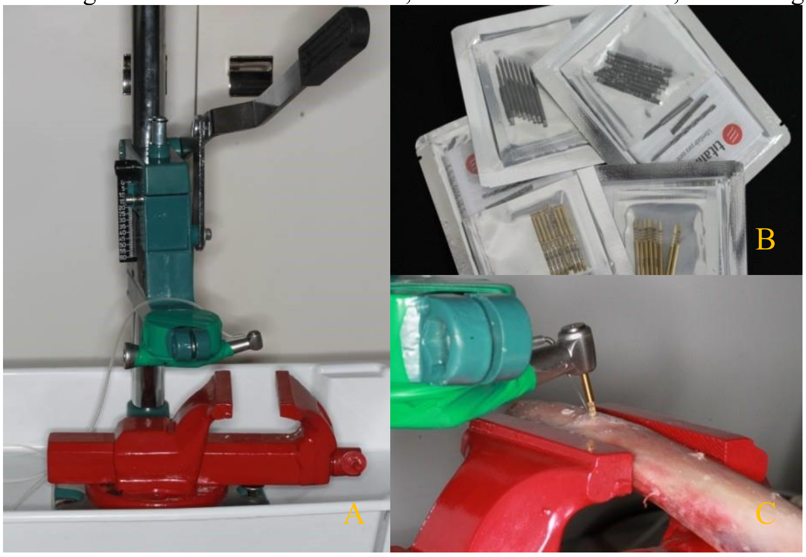
This animal model was chosen due to its good bone density and balance between the cortical and medullary portions, similar to the human mandibular bone (Mendes et al., 2014; Sartori et al., 2012). The ribs had the soft tissue and periosteum removed, the epiphyses discarded and were refrigerated at a temperature of 5°C.

It should be noted that the proposed project complies with Resolution No. 196, of October 10, 1996, of the National Research Ethics Council, and before being implemented, it was submitted to the Animal Research Ethics Committee of the Bahiana School of Medicine and Public Health, under number 0001/2014, and obtained unanimous approval for its execution without restrictions on May 22, 2014 (Annex 1).

Before performing the osteotomies, the ribs were thawed by immersion in saline solution (0.9% NaCl) and heated until their temperature was similar to the human body temperature of 37°C.

As a device for irrigation and milling, an electric motor (Surgic XT, Neodent, Curitiba, PR, Brazil) was selected, consisting of an attached peristaltic pump, allowing the use of irrigation at a speed of 1200rpm and a torque of 35N for the surgical preparation of the alveolus (Gehrke et al., 2013), and a 20:1 reduction contra-angle (NSK, Suzano, São Paulo, Brazil). Profuse external irrigation with 0.9% sodium chloride solution (Segmenta, Ribeirão Preto, São Paulo) was carried out throughout the preparation. Osteotomies were performed by a single calibrated operator. The contra-angle was coupled to an adapted mechanical arm with vertical movement (Figure 2), which provided constant guided pressure (Mendes et al., 2014; Sartori et al., 2012).

Figure 2: A- Contra angle attached to the verticalizer; B- Steel and DLC drills; C- Drilling length 7.0mm.



Source: Authors (2024)

Ninety-six TitaniumFix drills (São José dos Campos, São Paulo, Brazil) were used, 24 of which were steel spear drills, 24 steel spear drills with Diamond-Like Carbon (DLC) coating, 24 steel twist drills and 24 twist drills with DLC coating (Figure 2). The steel drills are characterized by a steel structure and titanium nitride (TiN) coating, and the DLC drills have a stainless steel structure and diamond-like carbon coating, both types of drill have a diameter of 2.0 mm and were used for bone drilling at a constant depth of 7.0 mm (Figure 2).

As an evaluation methodology, the set of drills was divided into four groups:

Group G0 (control), made up of 24 drills with a diameter of 2.0mm (06 Titanium Nitride (NiT) coated steel spear drills, 06 DLC carbon coated steel spear drills, 06 steel twist drills with Titanium Nitride coating and 06 steel twist drills with carbon DLC coating, which had never been used in osteotomies, subdivided into subgroups G0A and G0B respectively without sterilization, only cleaned with gauze and sterilized.

Group G1, similar to the previous group, represented 45 osteotomies subdivided into subgroups (G1A and G1B), where the drills in the subgroup (G1A) were subjected to 90 perforations without being sterilized, and those in the second subgroup (G1B) were sterilized.

Group G2 consisted of the same group of drills as the previous ones, which were used 90 times in osteotomies, also subdivided into subgroups (G3A and G3B), where the drills in subgroup (G3A) underwent 90 perforations without being sterilized, and the second subgroup (G2B) was sterilized.

Group G3, similar to the previous groups, was used 135 times in osteotomies, also subdivided into subgroups (G3A and G3B), where the drills of subgroup (G3A) were subjected to 135 perforations without being sterilized and the second subgroup (G2B) sterilized.

The colors were assigned to the groups according to Table 1.

Table 1: Colors referring to the groups worked on.

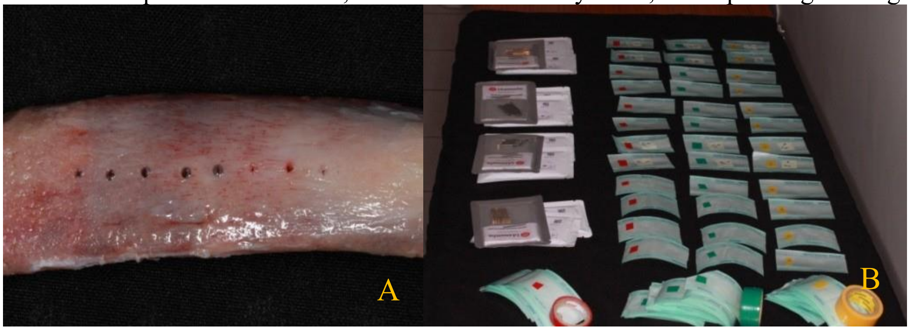
G1	🟨
G2	🟩
G3	🟥

It is worth noting that the common characteristics between the groups were initially evaluated using the control group (G0) as a reference, without any mechanical stress, and at the end of using all the samples from the three groups, they were compared.

LABORATORY PROCEDURES

As a laboratory procedure, a sequence of milling groups was followed with simple randomization, following the sequence of: first, a spear drill preceding all the milling, and then the use of a twist drill. The spear drill aimed to traverse the external cortical bone to a pre-established depth of 7.0mm in milling length, followed by a 2.0mm twist drill to a depth of 7.0mm, completing the osteotomy (Figure 3). All the drills were subjected to microphotography.

Figure 3: A- Completed osteotomies; B- Posts identified by color, corresponding to the group.



Source: Authors (2024)

After milling, each drill used was placed in a "post" and, after all the milling, they were redistributed into their specific groups; in relation to the corresponding groups to be sterilized, they were subjected to chemical processing and a specific sterilization step, completing the pre-established sequence for each of the groups (Figure 3).

STERILIZATION PROCEDURES

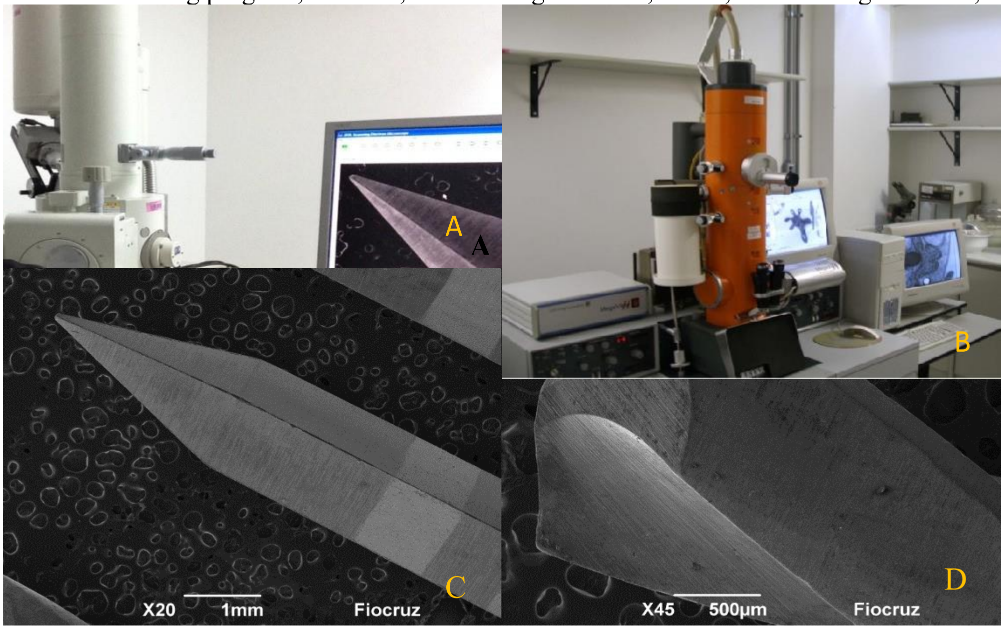
With regard to the disinfection and sterilization process, according to the guidelines adopted by the Bahian School of Medicine and Public Health (EBMSP), the instruments first go through a pre-washing, decontamination and rinsing process. Pre-washing is initially carried out by manual cleaning, which consists of immersing the material in a basket inside a container containing the enzymatic detergent Liquizime-Ruhof (Mineola, New York, USA) for a period of 3 minutes. The material is then washed with Atol neutral liquid detergent (Amparo, São Paulo, Brazil) using brushes.

The material is then rinsed and dried with clean cloths. At the end of these stages, the material is placed for sterilization in individual packages, envelopes of surgical grade paper associated with laminated polypropylene films (post). For the sterilization process, a moist heat autoclave (Cristófoli, Campos Mourão, Brazil) was used at a temperature of 127ºC, with sterilization cycles of 40 minutes and 15 minutes of drying.

MICROSCOPY PROCEDURES

The drills of the control group, G0A and G0B, were submitted to microscopy, and the other groups, after reaching the pre-established limit of osteotomies for each group and sterilization, were sent to the Electron Microscopy Service of the Oswaldo Cruz Foundation (FIOCRUZ), Gonçalo Moniz Research Center. The drills were stabilized with double-sided carbon tape on the sample evaluation table for analysis by scanning electron microscopy (SEM), JOEL JSM-6390LV, 3 nm resolution at 30 Kv (high vacuum mode) and 4nm at 30Kv (low vacuum mode), with a microanalysis system (Figure 4).

Figure 4: A- Processing program; B- SEM; C- 20X magnification, G0SE; D- 45X magnification, G1SE.



Source: Authors (2024)

Word Distance (WD) = 38, Spot Size (exit from the column tip to the sample) = 40, and Acceleration voltage = 8 were used as references, and 45x and 20x magnifications were made using the Sem Main Menu program and photomicrographs of the respective images were taken (Figure 4).

The drills were analyzed and compared with the parameters extracted from the control group (G0). The qualitative damage parameters were established according to the table 2 below:

Table 2: Qualitative damage parameters.

SCORE	TYPE OF CHANGE	CODE
0	No change	AA (No Change)
1	Presence of grooves, cracks and delamination	AI (Initial Change)
2	Presence of a crater	AM (Media Change)
3	Shape Deformation	AMX (Maximum Change)

STATISTICAL METHODS USED

The statistical analysis of the results obtained was carried out using the so-called "non-parametric statistical tests", Mann-Whitney and Friedman for paired samples, which are tests to define the level of similarity or difference between two moments in the same sample or population, and Dunn's test was used for significant differences between pairs. This last test studies the differences between two situations in the same population to assess significance.

The database was created in Excel 2003 and analyzed in R Software (version 3.1.2). A descriptive analysis (median and quartiles) was carried out to identify the general and specific characteristics of the sample studied.

RESULTS

Evaluating the overall level of wear of the drills after use, Friedman's statistical analysis and the evaluation of significant differences between pairs using Dunn's post-hoc test showed that there was physical alteration of the drills in group G3. A p-value < 0.001 was obtained for the association between group G3 and the other groups, determining that the drills in this group had suffered significant wear (Table 3).

The table below shows the statistical significance of the physical changes suffered, both for the G3A group drills used up to 135 times without being sterilized, and for those that underwent the sterilization process (G3B), $p < 0.001$ comparing them with the other groups. However, no significant changes were observed between the G0, G1 and G2 groups (Table 4).

The superscript letters a and b in Tables 3 and 4 indicate that there was no statistically significant difference between the groups with similar letters, but between the groups with different letters, there was a difference characterized by a p-value < 0.001.

Table 3 - Correlation between drill wear and number of uses.

	Variables	**Median**	**Q1-Q3**
	Control	0^a	0-0
Osteotomy 45	0^a	0-0	
Osteotomy 90	0^a	0-1,0	
	Osteotomy 135	$2{,}5^b$	1-3
	p-valor	**<0,001**	

a,b Different letters indicate significant differences between pairs by Dunn's test.

Table 4 - Correlation between drill wear, number of uses and influence of sterilization

Sterilization					
	No		**Yes**		**p-value**
Variables	**Median**^{1}	**Q1-Q3**	**Median**^{2}	**Q1-Q3**	
Control	0^a	0 – 0	0^a	0 - 0	**1,000**
Osteotomy 45	0^a	0 – 0	0^a	0 - 0,75	**0,514**
Osteotomy 90	0^a	0 - 0,75	$0{,}5^a$	0 - 2,5	**0,242**
Osteotomy135	2^b	1 – 3	$2{,}5^b$	2,0 - 3,0	**0,514**
p-value	**<0,001**		**<0,001**		

^{1,}2 Different letters in the columns indicate significant differences between the pairs using Dunn's test.

^{a,b} Different letters indicate significant differences between pairs according to Dunn's test.

Analysis of the SEM images showed that after 45 osteotomies there was little wear on the drills; however, the LC drills showed signs of geometric deformation at the active tip, but this was not statistically significant. Analysis of the microphotographs of the steel drills showed a more regular surface image compared to the carbon drills. However, there were no statistically significant differences.

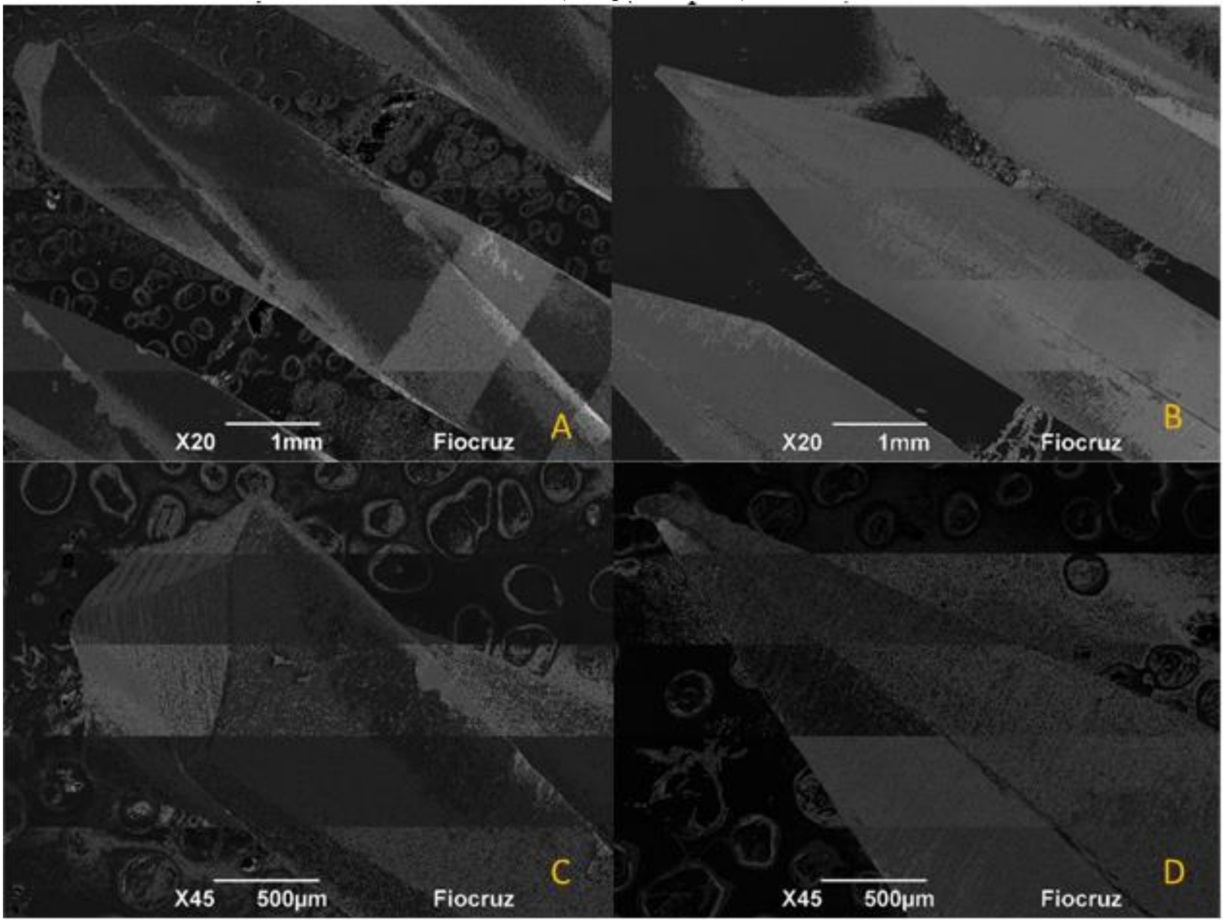
The existence of physical change in the groups was confirmed after SEM analysis. This loss occurred gradually after 45 osteotomies and was directly proportional to the number of perforations made.

No wear was seen in the G1 group, while that seen in G2 was recorded mainly as cracks and grooves. There were also no significant changes between the sterilization subgroups compared to the non-sterilization subgroups. Cracks and grooves were observed in scanning electron microscopy by checking for the presence of deformation zones in the samples. Substrate loss or delamination was more strongly confirmed in the DLC twist drills of Group G3.

Further analysis of Table 2 allows comparisons to be made between drills from the same group, evaluating their subgroups with the p-value of this comparison represented in the rows of the table, and in the columns, a comparison between the times, also with the p-value recorded.

Some deformations were evident in the SEM, such as the deformation suffered by an LA drill from G3, which revealed an active tip with maximum change in shape; and a carbon twist drill showing craters, suggesting it was contraindicated for reuse (Figure 5).

Figure 5: A- Carbon helical drill with crater-type wear; B- Steel spear drill with no wear; C- LA, G3 without sterilization and with AMx deformation; D- Carbon helical drill G3 (135 perforations).



Source: Authors (2024)

Between the steel and carbon twist drills after milling, regardless of sterilization, there was a significant difference after the osteotomies applied in Group G2, where the HC showed evidence of wear, and this obtained a $p = 0.015$ and $p < 0.05$. (Tables 5 and 6).

Table 5 - Correlation between helical drills and number of uses.

Type of drill					
	HA		**HC**		**p-value**
Variables	**Median**	**Q1-Q3**	**Median**	**Q1-Q3**	
Control	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 45	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 90	0	0 – 0	1	0,75 – 1	**0,015**
Osteotomy135	1,5	1 – 2,25	1,5	1- 2,25	**1,000**

Table 6 - Correlation between helical drills and the number of uses without sterilization.

Type of drill					
	HA		**HC**		**p-value**
Variables	**Median**	**Q1-Q3**	**Median**	**Q1-Q3**	
Control	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 45	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 90	0	0 – 0	1	0 - 1	**0,200**
Osteotomy135	1	1 – 3	1	1- 3	**1,000**

In the images of Group G2 (90 osteotomies), although there was no significant difference ($p > 0.05$) in most of the evaluations, there were areas where there was a process of delamination, which is the physical separation of part of the metal of an instrument (Sastry et al., 2014) from the coating on the surface of the HC drill, as well as signs of changes in the cutting edge of the HC drills when compared to the HA, $p < 0.05$.

Evaluating the twist drill groups after milling without sterilization, in the table above, it can be seen that there was no significant difference between the twist drills. However, there was a specific change in the HC group after 90 osteotomies and sterilization, as shown in Table 7.

Table 7 - Correlation between helical drill coatings, number of uses and sterilization.

Type of drill					
	HA		**HC**		**p-value**
Variables	**Median**	**Q1-Q3**	**Median**	**Q1-Q3**	
Control	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 45	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 90	0	0 – 0	1	1 - 1	**0,100**
Osteotomy135	2	1 – 2	2	1- 2	**1,000**

Comparing the coatings of the lanced drills of the proposed groups, no difference was found between these types of drills, even after evaluation of the experiment with sterilization and statistical analysis (Table 8).

Table 8 - Correlation between spear drills and number of uses.

Type of drill					
	HA		**HC**		**p-value**
Variables	**Median**	**Q1-Q3**	**Median**	**Q1-Q3**	
Control	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 45	0	0 – 0	2	0 - 2	**0,065**
Osteotomy 90	0	0 – 0	2,5	0 - 3	**0,065**
Osteotomy135	3	3 – 3	3	1- 3	**0,394**

With regard to the wear caused by the sterilization process, the DLC lance drills in G2 showed deformation of the cutting region and small areas with signs of coating loss on the active tip, although this was not statistically significant ($p > 0.05$). (Tables 9 and 10).

Table 9 - Correlation between lance drills, number of uses and sterilizations.

Type of drill					
	HA		**HC**		**p-value**
Variables	**Median**	**Q1-Q3**	**Median**	**Q1-Q3**	
Control	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 45	0	0 – 0	3	1 - 3	**0,100**
Osteotomy 90	0	0 – 0	3	3 - 3	**0,100**
Osteotomy135	3	3 – 3	3	3- 3	**1,000**

Table 10 - Correlation between spear drill coatings, number of uses without sterilization.

Type of drill					
	HA		**HC**		**p-value**
Variables	**Median**	**Q1-Q3**	**Median**	**Q1-Q3**	
Control	0	0 – 0	0	0 - 0	**1,000**
Osteotomy 45	0	0 – 0	0	0 - 3	**0,700**
Osteotomy 90	0	0 – 0	0	0 - 2	**0,700**
Osteotomy135	3	3 – 3	1	1- 3	**0,200**

DISCUSSION

In a study similar to this one, carried out by Sartori et al. (2012), which aimed to comparatively evaluate the deformation, roughness and loss of mass of three types of dental drills made of different materials, all used in osteotomies for the installation of osseointegratable implants, structural loss occurred from the initial group onwards, which differs from this one in that it was visualized from G2 onwards.

The studies by Sartori et al. (2012), Mendes et al. (2014) and Santos et al. (2014) concur with the statement that there is a correlation coefficient between the reuse of drills and their deformation.

With regard to the study by Sartori et al. (2012), they carried out visual verification tests using SEM, which revealed areas of deformation in all the 2.0mm samples and irregular deformation in the 3.0mm samples.

Sartori et al. (2012) concluded that in all groups there was a loss of cutting power after the 40th drill for 2.0mm drills; there were wear marks in all groups of 2.0mm drills when compared to 3.0mm drills, similar to the present study which observed initial wear from the 45th drill, in carbon-coated drills, but without significance. Similarly, Chauhan et al. (2018) observed in their systematic review that drills should not be used for more than 40 osteotomies, recommending the use of sharp drills to minimize surgical trauma.

It can be seen that this maximum limit of drills varies greatly between studies, as cited by Oliveira et al. (2012), Carvalho et al. (2011) and Allsobrook et al. (2011), where the limit is raised to more than 50 drills, as they state that before this, there is no production of temperatures harmful to bone tissue or even serious signs of wear and deformation of the drills.

Mendes et al. (2014) evaluated the influences on implants resulting from the wear, deformation and roughness of the drills after repeated drilling and sterilization processes. For this purpose, they used drills made of three different materials, which were grouped as follows: G1 -

stainless steel; G2 - DLCoated (diamond-like carbon coated); and G3 - zirconia. These groups were further subdivided into five subgroups 1, 2, 3, 4 and 5, which corresponded, respectively, to the minimum use of drills 0 (not used), 10, 20, 30 and 40 times.

Subsequently, in the study by Mendes et al. (2014), the drills were washed with water, dried with compressed air jets and sterilized in an autoclave at 127°C for 40 minutes. It is worth noting that mass, SEM and roughness measurements were taken before and after the drilling procedure and sterilization cycles in each of the groups and subgroups. The results of the study revealed that the drills of the three groups, with their respective subgroups, did not show significant differences in mass, however, in this study, the sterilization process took place after a series of five osteotomies.

Although greater wear processes were observed in the carbon twist drills than with the same type of steel drill, this result contradicts what was found in a study by Allsobrook et al. (2011), where the drills made with tungsten carbide coating obtained the following performance: lower drilling temperatures, less plastic deformation and surface corrosion.

However, Mendes et al. (2014), in the SEM analysis, observed that all the drills showed signs of wear characterized by damage to the cutting surface. At the end of the experiment, the author concluded that, collectively, no significant differences were detected in relation to the mass and roughness of the drills; however, repeated use of the drills increases wear, reducing cutting efficiency and, consequently, increasing the heat of friction, similar to the present experiment.

With regard to the comparative analysis of the drills used in the preparation of the surgical socket, the sterilization method proposed in this study is in line with the work of Ciuccio et al. (2010) and Fais et al. (2011), who state, respectively, that the heat treatment applied to dental drills gave them resistance to autoclaving and corrosion, and that the method proposed for cleaning and disinfecting the instruments, studied and employed here, causes little damage to the cutting efficiency compared to other methods.

According to Alevizakos et al. (2021), the sterilization process can affect the main cutting edges of the drill; however, in order to gain a better understanding of the relationship between implant holder preparation and the influence of sterilization on drill performance and wear, further studies are required.

It was also evident in this study that there is greater change in spear drills compared to twist drills. The same can also be confirmed in the study by Carvalho et al. (2011), where the greatest thermal change was seen in the preparation of the surgical bed with the spear-type drill due to its association with the wear suffered.

The research by Santos et al. (2014), which aimed to evaluate and compare bone heating, drill deformation and changes in roughness after osteotomies for dental implants, used 20 rabbit tibias, divided into two groups: CG - control group and GG - guided surgery. This GG group was subdivided into five subgroups called GO, G1, G2, G3 and G4, corresponding respectively to the number of times the drill was used: 0, 10, 20, 30 and 40. In the study in question, after using the drills, the thermal changes were evaluated and it was observed that there was a significant change in temperature in GG and that the deformation of the drill was progressive, proportional to use.

At the end of the study, Santos et al. (2014) made the following extremely relevant comments: they stated that the bone heating generated during osteotomy procedures can cause necrosis in the cortical area and/or affect the entire tissue region; they stated that the extent of necrosis varies according to factors such as the osteotomy, and that irrigation directly controls the temperature; stated that the repeated use of drills during the preparation of the recipient bed can increase wear, reducing the effectiveness of drilling and causing more friction; emphasized that the guidelines that support the dentist's decision to replace the drill are still very empirical; and, finally, concluded that guided surgery can limit irrigation within the active point of the drill.

CONCLUSIONS

Within the limitations of this study and based on the methodology followed, it can be concluded that: The physical changes of the drills were significant after 90 osteotomies. The TiN-coated steel twist drills in G2 showed lower levels of wear than the DLC-coated drills in the same group. The sterilization process did not generate statistically significant changes in the groups studied.

REFERENCES

1. Alevizakos, V., Mitov, G., Ahrens, A., & See, C. V. (2021). The Influence of Implant Site Preparation and Sterilization on the Performance and Wear of Implant Drills. *The International Journal of Oral & Maxillofacial Implants*, 36(3), 546–552. https://doi.org/10.11607/jomi.8099.

2. Alevizakos, V., Mosch, R., & See, C. V. (2023). Influence of Multiple Used Implant Drills on Their Cutting Performance and Fracture Resistance. *Materials*, 16(15), 5271–5271. https://doi.org/10.3390/ma16155271.

3. Allsobrook, O. F. L., Leichter, J., Holborow, D., & Swain, M. (2009). Descriptive Study of the Longevity of Dental Implant Surgery Drills. *Clinical Implant Dentistry and Related Research*, 13(3), 244–254. https://doi.org/10.1111/j.1708-8208.2009.00205.x.

4. Barbosa, P. A. (2009). Furação de ferro fundido austemperado e nodular perlítico [Tese, Universidade Federal de Engenharia Mecânica de Uberlândia]. Uberlândia (MG) Brazil.

5. Bertolete, M. C. (2009). Determinação da vida de brocas utilizadas em implantodontia e influência das condições de corte [Dissertação, Universidade Federal de Uberlândia, Escola de Engenharia Mecânica]. Uberlândia (MG) Brazil.

6. Carvalho, A. C., Queiroz, T. P., Okamoto, R., Margonar, R., Garcia, I. R., & Filho, O. M. (2011). Evaluation of bone heating, immediate bone cell viability, and wear of high-resistance drills after the creation of implant osteotomies in rabbit tibias. *International Journal of Oral & Maxillofacial Implants*, 26(6), 1193–1201.

7. Chauhan, C., Shah, D., & Sutaria, F. (2018). Various bio-mechanical factors affecting heat generation during osteotomy preparation: A systematic review. *Indian Journal of Dental Research*, 29(1), 81–92. https://doi.org/10.4103/ijdr.ijdr_729_16.

8. Ciuccio, R. L., Luiz, N. E., Filho, A. J., & Aislan, M. (2010). Determinação das resistências à esterilização em autoclave, à corrosão e à exposição térmica de instrumental cirúrgico: Estudo de caso. *Innov. Implant*, 5(2), 40–44.

9. Comar, K. (2006). A relação entre o desgaste das brocas e o aumento de temperatura e carga durante a perfuração óssea em implantodontia [Dissertação, Universidade de Santo Amaro, Faculdade de Odontologia]. São Paulo (SP) Brazil.

10. Cordioli, G., & Majzoub, Z. (1997). Heat generation during implant site preparation: An in vitro study. *International Journal of Oral & Maxillofacial Implants*, 12(2), 186–193.

11. Dearnaley, G., & Arps, J. H. (2005). Biomedical applications of diamond-like carbon (DLC) coatings: A review. *Surface and Coatings Technology*, 200(7), 2518–2524. https://doi.org/10.1016/j.surfcoat.2005.07.077.

12. Ercoli, C., Funkenbusch, P. D., Lee, H. J., Moss, M. E., & Graser, G. N. (2004). The influence of drill wear on cutting efficiency and heat production during osteotomy preparation for dental implants: A study of drill durability. *International Journal of Oral & Maxillofacial Implants*, 19(3), 335–349.

13. Eriksson, R. A., & Adell, R. (1996). Temperatures during drilling for the placement of implants using the osseointegration technique. *International Journal of Oral & Maxillofacial Implants*, 11, 44–47.

14. Fais, L. M. G., Scardueli, C. R., & Bordignon, D. C. (2011). Influência de diferentes métodos de limpeza sobre a eficiência de corte e as características morfológicas de fresas Carbide. *Revista Odontológica da UNESP*, 40(4), 166-173.

15. Gehrke, S. A., Neto, H. L., & Mardegan, F. E. (2013). Investigation of the effect of movement and irrigation systems on temperature in the conventional drilling of cortical bone. *British Journal of Oral and Maxillofacial Surgery*, 51(8), 953-957.

16. Iyer, S., & Weiss, C. M. (1997). Effects of drill speed on heat production and the rate and quality of bone formation in dental implant osteotomies: Part I - Relationship between drill speed and healing. *International Journal of Prosthodontics*, 10, 411.

17. Junior, P. D. R., Barleto, C. V., Ribeiro, D. A., & Matsumoto, M. A. (2007). Evaluation of different rotary devices on bone repair in rabbits. *Brazilian Dental Journal*, 18(3), 215–219.

18. Matthews, L. S., & Hirsch, C. (1972). Temperatures measured in human cortical bone when drilling. *Journal of Bone and Joint Surgery*, 54(2), 297-308.

19. Mendes, G. C. B., Padovan, L. E. M., Junior, P. D. R., Sartori, E. M., Valgas, L., & Claudina, M. (2014). Influence of Implant Drill Materials on Wear, Deformation and Roughness After Repeated Drilling and Sterilization. *Journal of Implant Dentistry*, 23(2), 188-194.

20. Migliorati, M., Amorfini, L., Signori, A., Barberis, F., Biavati, A. S., & Benedicenti, S. (2013). Internal Bone Temperature Change During Guided Surgery Preparations for Dental Implants: an in vitro study. *The International Journal of Oral & Maxillofacial Implants*, 28(6), 1464-1469.

21. Mishra, S. K., & Chowdhary, R. (2014). Heat generated by dental implant drills during osteotomy: a review. *Journal of Indian Prosthodontic Society*, 12(2), 131-143.

22. Oliveira, N., Alaejos-Algarra, F., & Mareque, J. (2012). Thermal changes and drill wear in bovine bone during implant site preparation. A comparative in vitro study: twisted stainless steel and ceramic drills. *Clinical Oral Implants Research*, 23(8), 963-969.

23. Omar, S., Jaiswal, H., Mishra, S. K., Bhargava, D., & Kumar, P. (2023). A comparative study to evaluate the heat generated during osteotomy with conventional drill, trephine and alveolar expander. *European Oral Research*, 57(1), 22-27.

24. Paterno, J., Joly, J. C., & Abrão, C. V. (2011). Evaluation of bone heating and drill wear of different dental implant systems: in vitro study Dario. *Revista Implantnews*, 8(5), 601-608.

25. Queiroz, T. P., Souza, F. A., Okamoto, R., Filho, V. A. P., Margonar, R., & Gulinelli, J. L. (2007). Análise da viabilidade celular imediata e do desgaste das fresas após osteotomia para implantes. *Revista de Odontologia da UNESP*, 36, 1.

26. Roy, R. K., & Lee, K. R. (2007). Biomedical applications of diamond-like carbon coatings: a review. *Journal of Biomedical Materials Research Part B: Applied Biomaterials*, 83(1), 72-84.

27. Santos, P. L., Queiroz, T. P., Morgano, R., Carvalho, A. C. G. S., Junior, W. B., Rezende, R. R. R., Santos, P. H., & Junior, I. R. G. (2014). Evaluation of bone heating, drill deformation and drill roughness after implant osteotomy: guided surgery and classic drilling procedure. *International Journal of Oral & Maxillofacial Implants*, 29(2), 51-59.

28. Sartori, E. M., Shinohara, E. H., & Ponzoni, D. (2012). Evaluation of deformation, mass loss, and roughness of different metal burs after osteotomy for osseointegrated implants. *Journal of Oral and Maxillofacial Surgery*, 70, 608e-621e.

29. Sastry, K. V., Rao, V. S., Palanikumar, K., Dhanalakshmi, R., & Kuravi, A. (2014). Assessment of Process Parameters Influencing Delamination Factor on the Drilling of CFRC Composite Material with TiN Coated Carbide Tool. *Indian Journal of Science and Technology*, 7(2), 142–150.

30. Scarano, A., Piattelli, A., & Assenza, B. (2011). Infrared thermographic evaluation of temperature modifications induced during implant site preparation with cylindrical versus conical drills. *Clinical Implant Dentistry and Related Research*, 13(4), 319-323.

31. Sharma, S., Shankar, R., & Srinivas, K. (2014). Epidemiological Study on the Selection, Usage and Disposal of Dental Burs among the Dental Practitioners. *Journal of Clinical and Diagnostic Research*, 8(1), 250-254.

32. Strbac, G. D., Giannis, K., Unger, E., Mittlbock, M., Watzek, G., & Zechner, W. (2014). A novel standardized bone model for thermal evaluation of bone osteotomies with various irrigation methods. *Clinical Oral Implants Research*, 25(6), 622-631.

33. Strbac, G. D., Unger, E., Donner, R., Bijak, M., Watzek, G., & Zechner, W. (2014). Thermal effects of a combined irrigation method during implant site drilling. A standardized in vitro study using a bovine rib model. *Clinical Oral Implants Research*, 25(6), 665-674.

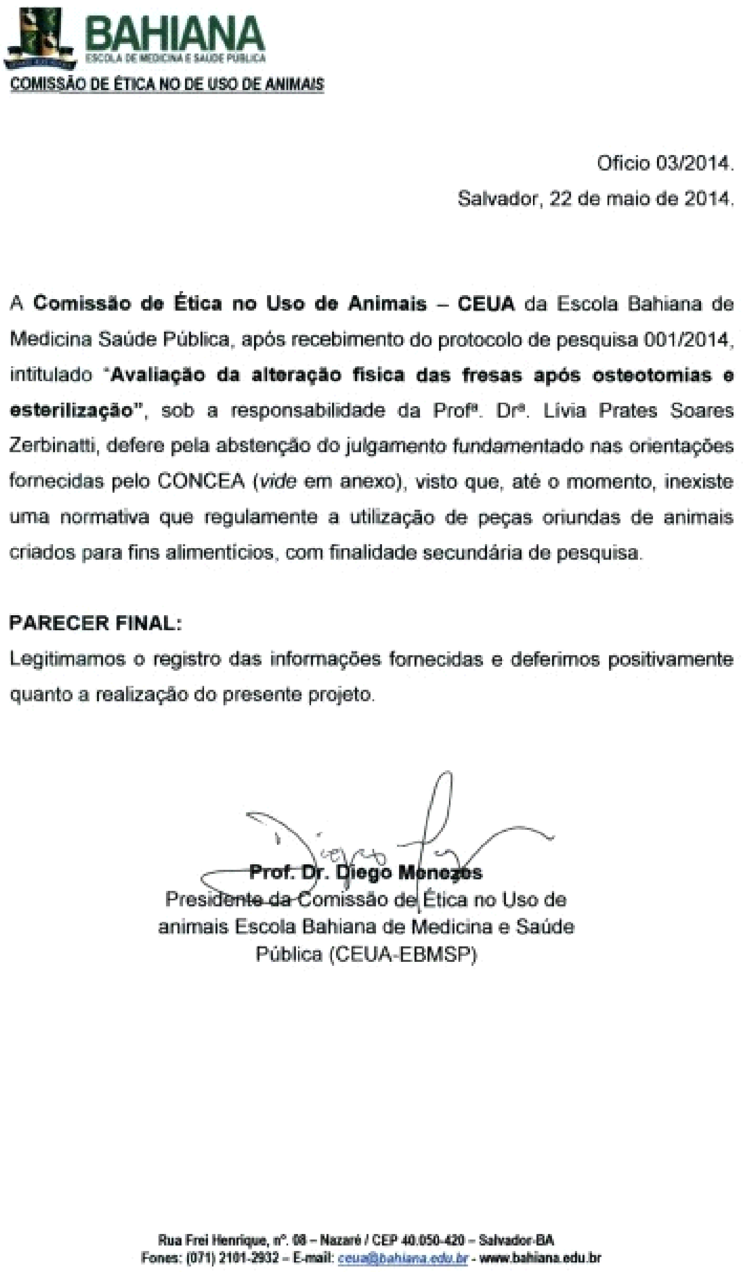
34. Tur, D., Giannis, K., Unger, E., Mittlbock, M., Rausch-Fan, X., & Strbac, G. D. (2020). Thermal effects of various drill materials during implant site preparation—Ceramic vs. stainless steel drills: A comparative in vitro study in a standardized bovine bone model. *Clinical Oral Implants Research*, 32(2), 154–166. https://doi.org/10.1111/clr.13685.

35. Vasconcelos, V. S. L. (2012). Avaliação do desempenho de fresas cirúrgicas para implantes osseointegráveis. [Dissertação, Ministério da Defesa, Exército Brasileiro, Instituto Militar de Engenharia, Departamento de Ciência e Tecnologia]. Rio de Janeiro (RJ) Brazil.

ANNEX

ANNEX 1

Ethics Committee Approval



BAHIANA
ESCOLA DE MEDICINA E SAÚDE PÚBLICA
COMISSÃO DE ÉTICA NO DE USO DE ANIMAIS

Oficio 03/2014.
Salvador, 22 de maio de 2014.

A **Comissão de Ética no Uso de Animais – CEUA** da Escola Bahiana de Medicina Saúde Pública, após recebimento do protocolo de pesquisa 001/2014, intitulado "**Avaliação da alteração fisica das fresas após osteotomias e esterilização**", sob a responsabilidade da Profª. Drª. Lívia Prates Soares Zerbinatti, defere pela abstenção do julgamento fundamentado nas orientações fornecidas pelo CONCEA (*vide* em anexo), visto que, até o momento, inexiste uma normativa que regulamente a utilização de peças oriundas de animais criados para fins alimentícios, com finalidade secundária de pesquisa.

PARECER FINAL:
Legitimamos o registro das informações fornecidas e deferimos positivamente quanto a realização do presente projeto.

Prof. Dr. Diego Menezes
Presidente da Comissão de Ética no Uso de animais Escola Bahiana de Medicina e Saúde Pública (CEUA-EBMSP)

Rua Frei Henrique, nº. 08 – Nazaré / CEP 40.050-420 – Salvador-BA
Fones: (071) 2101-2932 – E-mail: ceua@bahiana.edu.br - www.bahiana.edu.br