Biodental Engineering III – Natal Jorge et al. (Eds)
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Analysis of autoclave induced dimensional changes on addition silicones

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ABSTRACT: Researchers and clinicians have become increasingly concerned with disinfection and sterilization of instruments and materials. The possibility of cross infection by dental impressions has required its disinfection prior to casting of gypsum. The aim of this work is to study the dimensional changes of dental impressions with addition silicone (Affinis®) determining whether it has dimensional stability allowing its sterilization. The sample is characterized by a group of 15 models obtained from autoclaved impressions and a control group of 15 models obtained from not autoclaved impressions. We compared the dimensional changes of the models and searched for statistically significant differences. Autoclaving of addition silicone impressions produced statistically significant dimensional changes in points of the vestibular areas. However, these changes seem clinically irrelevant. Results seem to support that addition silicone (Affinis®) can be autoclaved without compromising the final restoration. More studies are needed to confirm these hypotheses.

1 INTRODUCTION

1.1 *Cross-infection control*

Control of cross-infection in dental impressions has long been cause for concern among dentists and dental technicians. A simple washing of the prints removes only part of the microbial flora. The American Dental Association (ADA) (ADA council 1996) suggests that the silicones should be washed in running water and then disinfected. Despite this, many dentists do not disinfect their impressions, such as in the UK (23%) (Jagger et al. 1995) or in India (67%) (Bhat et al. 2007). In the USA, the disinfection protocol is widely used but communication between the doctors and the lab is very poor, (Kugel et al. 2000) and microorganisms were found in 67% of impressions sent to the laboratory. (Powell et al. 1990) Muller-Bolla et al. (2004) demonstrated that in the dental faculties in Europe, including Portugal, 75% of departments engaged in some type of disinfection on impressions. Pang & Millar (2006) concluded that only 48% of dentists sterilized or disinfected impressions. The study of disinfection of impressions began in the 50's (Gilmore et al. 1959, Pleasure et al. 1959), in the 70's the transmission of infectious diseases was investigated and in the 80's antimicrobial agents were incorporated in alginates (Soares & Ueti 2001).

The sterilization of impressions with quimioclave, ultraviolet rays, hypochlorite, iodine compounds, chlorhexidine solutions and autoclave (Johansen & Stackhouse 1987) were considered costly, time consuming and could change dimensionally impressions. As a practical alternative disinfection took place (Lagenwalter et al. 1990). Studies on dimensional changes caused by disinfectants concluded that immersion within 60 minutes of addition silicones in sodium hypochlorite 10,000 ppm was the safest method, (Minagi et al. 1986) and that after immersion in a solution of 2% glutaraldehyde for 10 hours, showed high stability. (Johansen & Stackhouse 1987) Several authors (Bergman 1989, Langenwalter et al. 1990, Matyas et al. 1990, Tullner et al. 1988) reported dimensional changes in polivynilsiloxanes after disinfection, although clinically insignificant. Pratten et al. (1990) demonstrated changes in wettability caused by disinfectants in hydrophilic silicones. Martin et al. (2007) reported the lack of consensus protocols and the presence of unknown substances in silicones, leading to different behaviors in contact with disinfectants. Different authors, (Bock et al. 2008, Kotsiomiti et al. 2008, Melilli et al. 2008) concluded that chemical disinfection produces dimensional changes that do not influence the clinical outcome.

1.2 *Sterilization of addition silicones*

With respect to the sterilization of addition silicones Holtan et al. (1991) studied the changes produced by sterilization using an autoclave and a quimioclave, with metallic trays. They reported statistically significant changes when used autoclave at 132°C, but no statistically significant changes with quimioclave at 71°C. Olin et al. (1994) found dimensional changes produced by quimioclave sterilization, autoclave and soaking for 12 hours in 2% glutaraldehyde when using acrylic trays. More recent studies such as Brian Millar (1999) and Kollefrath et al. (2010) tested sterilization on autoclave at 134°C with addition silicone impressions Affinis®, concluding that it did not suffer dimensional changes. Also Christensen (2010) features autoclaving as an alternative to disinfection, reporting a dimensional change of less than 0.7%, lower than the 1.5% allowed by the ADA.

1.3 *Disinfection versus sterilization*

Rios et al. (1996) and Abdelaziz et al. (2004) stated that there is no consensus on the disinfection/sterilization of impression materials. Some authors concluded that the use of disinfectants affects dimensional stability and wettability of addition silicones and chemically react with gypsum. (Bergman 1989, Johansen & Stackhouse 1987, Kotsiomiti et al. 2008, Langenwalter et al. 1990, Matyas et al. 1990, Minagi et al. 1986, Rios et al. 1996, Tullner et al. 1988) These changes increase with time of exposure to the disinfectant and professionals often keep impressions less time in contact with disinfectant than recommended. (Langenwalter et al. 1990, Martin et al. 2007, Rios et al. 1996) Several studies attest, (Matyas et al. 1990, Minagi et al. 1986, Peixoto et al. 2007) or contest (Powell et al. 1990) the effectiveness of disinfection and disinfectants used. Sterilization, being more lethal to pathogenic microorganisms, should be preferred, (ADA council 1996) because disinfection is less precise when it comes to safety margins (Martin et al. 2007, Fraise et al. 2004). Sterilizing silicone impressions in autoclave, as proposed by the manufacturer Coltène Whaledent™ with Affinis®, the trays and the specific adhesive marks a significant step in the control of cross-infection, which needs to be studied in depth.

2 OBJECTIVES

2.1 *Objective*

The aim of this work is to study the dimensional changes of dental impressions with addition silicone determining whether it has dimensional stability allowing its sterilization with autoclave at 134 °C without compromising the final restoration.

3 MATERIAL AND METHODS

3.1 *Study design*

We developed a pattern model (Fig. 1) consisting of an acrylic base model with nine natural teeth, a cylinder simulating a tooth preparation and three balls (technical analysis). This pattern model allows only one axis of insertion and detachment, standardizing impressions.

From this model we obtained 30 impressions by the technique of double mixture with Affinis® silicones. In 15 of them were used trays President® and adhesive Coltène® and, in the remaining 15, trays President AC® and adhesive Coltène AC® which are autoclavable. The latter 15 impressions were autoclaved, doing a short cycle of 134° C according to the manufacturer's instructions (Coltène/Whaledent™). In Affinis® silicones deformation by contraction is from 0.2% (Coltène Whaledent AG) to 0.24% (3M ESPE 2007). To compensate this contraction it is important that gypsum produces a similar expansion. Thus, we chose Whipmix ResinRock® XL5 (Whipmix.com) with 0.2% expansion. All impressions were cast with plaster in a vacuum mixer following the instructions of the manufacturer. (Whipmix.com).

Then, the pattern model and all the obtained models of gypsum from the 30 impressions were scanned with a 3D high resolution scanner (STEINBICHLER COMET VarioZoom 2M C200/400; Measuring area (mm3): 200 × 150; Resolution in Z (mm): >=0,002–0,004; Precision: aprox. 0,015 mm; Software: Comet Plus 6.5; Comet Inspect 3.01).

The dimensional changes caused by the two different processes were calculated by Best-Fit method, using 34 fixed points for comparison between models (Fig. 2).

Figure 1. Pattern model.

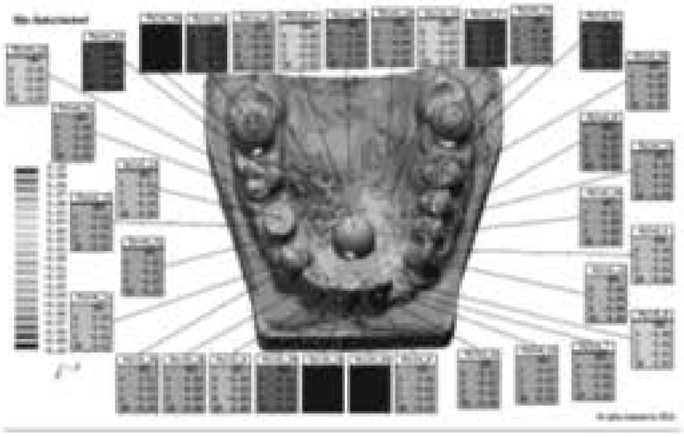

Figure 2. Avaliation of dimensional changes of gypsum models compared with pattern model (34 fixed points).

These data were entered into SPSS 19.0 program for statistical analysis. The Lilliefors and Kolmogorov-Smirnov tests were applied for symmetry and normality of the distribution, and Mann-Whitney test and t-test were applied for group means. We compared the dimensional changes of the autoclaved and non-autoclaved obtained models with the pattern model and searched for statistically significant differences.

The 34 points were then grouped in 7 areas: occlusal right, occlusal left, occlusal anterior, vestibular right, vestibular left, vestibular anterior and palatine.

4 RESULTS

4.1 *Dimensional changes*

The dimensional changes were studied on each point using Best-Fit method. The Mann-Whitney test and t-test were applied in search for statistically significant differences, first for each axis and then on 3D. Table 1 shows the points that presented statistically significant differences between the autoclaved and non-autoclaved models when compared to the pattern model. Point 26 only had statistically significant dimensional changes in axis Y and those changes were not enough to produce a statistically significant change when the 3 dimensions were analised.

On table 2 we show the points with statistically significant dimensional changes divided by region. The affected regions were mainly the vestibular regions and one point of the palatine region. There were no alterations on the points of the occlusal regions.

Within the statistically significant dimensional changes, the point with greater dimensional change for either autoclaved or non-autoclaved silicones was the point 34, whose average distortion to the pattern model was 146 µm (non-autoclaved) and

Table 1. Points with statistically significant dimensional changes.

Axis	X	Y	Z	3D
Points with statistically significant dimensional changes	15	15	15	15
	21	21	21	21
	23	23		23
	24	24	24	24
	30	30	30	30
	32	32	32	32
	33	33		33
	34	34	34	34
		26		

Table 2. Points with statistically significant dimensional changes by region.

Region	VR	VL	VA	OR	OL	OA	P
Points with statistically significant dimensional changes	24	32	21				15
	26	33	23				
		34	30				

VR(4)-vestibular right, VL(4)-vestibular left, VA(7)-vestibular anterior, OR(3)-oclusal right, OL(4)-oclusal left, OA(5)-oclusal anterior, P(7)-palatine. The numbers inside parentheses are the total number of points in each region.

97 µm (autoclaved). Sterilization resulted in an increase of the standard deviations and means of dimensional changes.

5 DISCUSSION

Disinfectants and autoclaving cause statistically significant dimensional changes in impressions. These are considered clinically irrelevant by various authors regarding disinfection, (Bergman 1989, Bock et al. 2008, Johansen & Stackhouse 1987, Kotsiomiti et al. 2008, Langenwalter et al. 1990, Matyas et al. 1990, Melilli et al. 2008, Rios et al. 1996, Tullner et al. 1988) but only by a few in sterilization. (Christensen 2010, Kollefrath et al. 2010, Millar 1999).

From our study, which focuses on this latter aspect, it can be inferred from Tables 1 and 2 that with the exception of point 15 (Palatine), all points with statistically significant dimensional changes are vestibular, which agrees with the results of Holtan et al. (1991), Olin et al. (1994) and Kollefrath et al. (2010) who reported that the areas of greatest susceptibility to dimensional changes were the ones with horizontal reduced thickness, so the tray should adequately support these areas. Probably the values of the statistically significant dimensional changes observed are related to this fact. Sterilization resulted in an increase of the standard deviations and means of dimensional changes, resulting in a less accurate impression.

Although we found statistically significant changes, they might be clinically irrelevant, given that the means and medians of the observed dimensional changes are not different in magnitude of the points where no statistical differences were found. Within the statistically significant dimensional changes, the point with greater distortion was the point 34, whose distortion was, actually, larger on the non-autoclaved models. Despite the fact of being statistically significant, we clearly see these alterations don't have the magnitude to be clinically relevant. Thus, the changes produced by autoclaving, where there is in most cases an increase of means and standard deviations when compared to non-autoclaved, given the magnitude of the alteration, are clinically irrelevant, although statistically significant. These results are consistent with the works of Millar (1999) and Kollefrath et al. (2010), but contrary of Holtan et al. (1991) and Olin et al. (1994).

We can say that if there is effective support from the tray and sufficient thickness of polyvinylsiloxane, sterilization of the impressions at 134° C is a safe, feasible solution, allowing stability and the most effective removal of microorganisms, making this method an excellent alternative to disinfection.

Rather than discussing the high-level disinfection is sufficient or not, it is necessary to take into account that we need a simple protocol, easy, cheap and quick to use, which does not happen with disinfectants. Furthermore, disinfection is more expensive than autoclaving, since the autoclave is of obligatory presence in dental practices and a cycle of autoclave can be faster than high degree disinfection. The environmental costs of disinfectants are also higher.

6 CONCLUSION

In our study, we observed statistically significant changes between autoclaved and not autoclaved impressions regarding the vestibular areas of the models, as well as larger standard deviations of the mean dimensional changes in the models resulting from autoclaved impressions.

Although autoclaving make inpressions less accurate given the small magnitude of the observed changes is likely that these do not result in clinically relevant changes since the impression has good thickness and involve the edges of the tray.

Thus, sterilization of silicone impressions addition autoclave is a handy, inexpensive and environmentally clean method, so it can be used in dentistry.

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