

# Does Steam Autoclaving Affect the Accuracy of Implant Impression Systems?

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**The purpose:** The aim of this *in-vitro* pilot study was to evaluate the effect of steam autoclaving of the implant analog and impression coping on the accuracy of impression procedure. **Materials and methods:** A master casts model was constructed, with a pair of commercially available fixtures. Ten pairs of impression copings were used to make the impression. Implant analogs were then attached to the copings and ten sets of duplicated casts were prepared and numbered. Baseline measurements were taken for all the ten casts using a travelling microscope. Two out of the ten sets of duplicated casts were randomly selected to be the control group. All the ten casts were manually broken and the analogs were retrieved. Excluding the control group, the remaining eight pairs of analogs and copings were sent for one, five and ten cycles of sterilization. The distances between the copings were measured using traveling microscope and compared to the distance in the master model. **Result:** No significant difference was observed in the mean value of the measured distances on the duplicated casts after steam autoclaving. **Conclusion:** Steam autoclaving the implant impression components did not influence the accuracy of the impressions procedure.

**Keywords:** Sterilization, Dental Implants, Accuracy of Impressions.

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## 1. INTRODUCTION

The clinical success of osseointegrated dental implants has led to a dramatic increase in their use worldwide. Clinical failure of an implant is costly due to the time and expense involved in implant placement and rehabilitation, both for the patient and the practitioner. In order to avoid bacterial penetration that could jeopardize either initial healing or long-term behaviour of implants, the formation of an early and long-standing effective barrier capable of biologically protecting the peri-implant structures is mandatory. Although the number of failures leading to exfoliation is numerically low, it is important to continue to improve the methodology involved in implant dentistry. The placement and restoration of dental implants require the use of numerous reusable instruments and components.<sup>6</sup> The primary disadvantage of instrument organizers is that the entire kit is contaminated when it is opened for a single instrument.

An imprecise impression may lead to implant failure as undue stress could develop on the various constituents of the prosthesis.<sup>5</sup> Precautions have to be observed during the various steps that finally lead to an implant structure, which imposes minimum stress on abutment and fixture.<sup>7</sup>

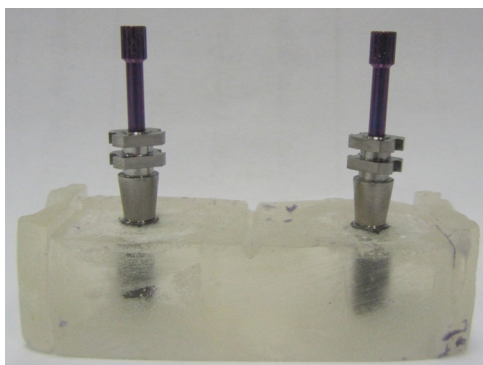
Sterilization is defined as a process that kills or removes all microorganisms, including resistant bacterial spores and from an object or product.<sup>12</sup> In implant therapy, multiple small components such as healing abutments, implant abutments, impression copings, retention screws, and screw drivers can get mixed and/or lost. Cleaning, sterilizing, and reorganizing these small components are very essential in a dental clinic. A clean surface has a high surface free energy, while a contaminated one has a lower surface energy.<sup>11</sup> Some sterilization techniques, such as autoclaving have been known to introduce significant amount of contaminants to the surface and mask the properties of the underlying titanium.<sup>17</sup> Much is still lacking in our understanding of the sterilization process that could possibly influence the outcome of the implant.

Although the causes for the failure of prosthesis are multifactorial, it must be assumed that prosthesis misfit plays an important role in complications such as screw loosening, screw fracture, plaque retention etc.<sup>4,19</sup> Therefore, care must be taken to minimize prosthesis misfit. There has been no clear consensus on the effect of sterilizing the impression coping and analog on the accuracy of the impressions made. The aim of this *in-vitro* pilot study was to evaluate the effect of different levels of steam sterilization on the accuracy of impressions procedure.

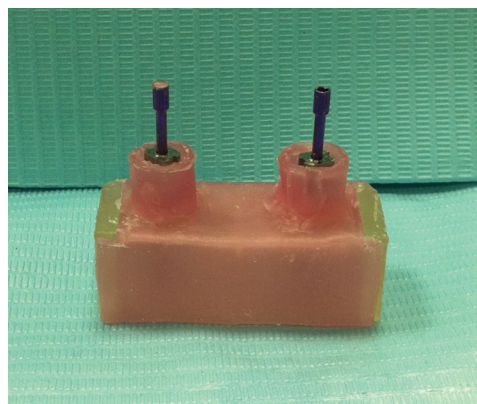
## 2. MATERIALS AND METHODS

A master model with a pair of Straumann® fixtures 4.1 mm × 12 mm (Bone level implant, SLA, Straumann®, ITI dental implant system, Straumann Institute, Waldenburg, Switzerland) was constructed and was labeled as “Master model” (Fig. 1). This was constructed from chemical-cured ortho resin (Orthoresin, Dentsply, DeguDent GmbH, Postfach, Hanau, Germany). The material was mixed and then poured in customized flasks that had been previously fabricated. The material was allowed to set according to the manufacturer’s instructions. After the setting, the blocks were taken out of the flasks and trimmed off the excess. Then, two points were marked on each block with a specific distance. Two holes were made using a straight hand piece (NSK, Japan), with a fissure bur at the marked points approximately 2.2 cm apart. Two Straumann® fixtures 4.1 mm × 12 mm (Bone level implant, SLA, Straumann®) were inserted and relined individually into the prepared holes. A Ney surveyor (Ney, Dentsply Ceramco Avenue York, PA, USA) was used to confirm an exact path of insertion of the two fixtures (Fig. 2). Straumann® Bone Level implants feature the CrossFit connection with four internal grooves. The reference points on the master model were the mesial corner of the bottom most groove as shown in the Figure 3.

In order to make final impression using open tray technique, a custom tray was fabricated (Fig. 4). Two of Straumann® impression copings (RC Impression post open tray, Straumann Institute, Waldenburg, Switzerland) were screwed and torque into the implant fixtures in the master model using the SCS screwdriver. To standardize the torque at 10N cm, the ratchet and the torque control device was used. One layer of wax spacer was applied, covering the superior surface of the master model without covering the impression coping and the cast stoppers. Then two layers of wax spacer were wrapped around the copings. Chemically cured polymethyl methacrylate acrylic resin (Bosworth Fastray™, The Harry J Bosworth company, IL, USA) was mixed and adapted over the wax spacer then the material was allowed to set according to



**Fig. 1.** Master Cast with two Straumann® Bone level implant fixtures (4.1 mm × 12 mm) with copings placed approximately 2.2 cms apart.



**Fig. 2.** Master model with spacer wax and implant copings.

the manufacturer’s instructions. Holes were made over the impression copings (using a straight hand piece with a fissure bur) and the thickness of the flanges was reduced from the inner surface to allow the excess impression material to escape during the impression making. A thin layer of poly ether adhesive (3 M ESPE Dental-Medizin GmbH & Co. KG, Seefeld, Germany) was applied to the custom trays and allowed to dry for 15 minutes before loading the tray with impression material. Polyether impressions were made using a pentamix mixing machine (3 M ESPE, Pentamix™ 2, Minnesota) and allowed to set according to the manufacturer’s instructions (Fig. 4). After loosening the positioning screw, the impression was removed from the master model. The impression coping remains embedded in the polyether impression material (Fig. 5). Implant analogs (RC bone level implant analog, Straumann Institute, Waldenburg, Switzerland) were then attached to the impression copings by means of a positioning screw and torque to 10N cm. The impression was poured with type IV dental stone (Fugirock, GC Europe, Belgium) with a Royal boxing wax wrapped around each tray. The mix was prepared using a vacuum-mixing machine and then poured under a vibrating machine (Vibromaster, GmBA & Co., Bremen, Germany). The material was allowed to set according to the manufacturer’s instructions. Then, the blocks were trimmed to refine the shape of the blocks. [Add figure showing the stone cast] The procedure was repeated and ten sets of casts were prepared and numbered. Baseline measurements were taken for all the ten casts using a travelling microscope. The measurements of



**Fig. 3.** Reference points on the head of the Straumann fixture.

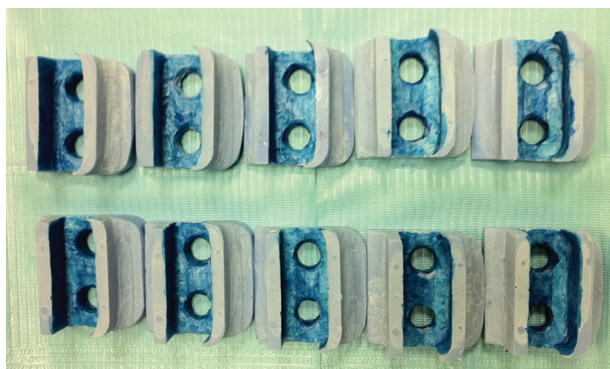


Fig. 4. Custom made impressions trays.

all the ten casts were taken using the predetermined reference points. Straumann® Measurements were taken using a traveling microscope (Titan, Buffalo, USA). The measurements were taken by fixing the casts on the microscope, which allowed a controlled movement of the casts. Three readings were taken for each casts and the average of the three readings was used to compare with the baseline readings. Two out of the ten sets of casts were randomly selected to be the control group (Cast Number 4 and 5).

All the ten casts were manually broken and the analogs were retrieved. Excluding the control group, the remaining eight pairs of implant analogs and impression copings were sent for one cycle of sterilization. Sterilization was achieved by steam autoclaving at 120 °C for 30 min (Amsco, Steris Corporation, Mentor, Ohio). The implant analogs were reattached to the impression copings and a new set of casts were prepared (Fig. 6). The same procedure was followed after sterilizing the analogs and impression copings five times and then ten times.

A paired sample *t*-test was performed using the SPSS program version 18.0, and then descriptive data analysis was used to report findings.



Fig. 5. Custom tray after making the final impression.



Fig. 6. Duplicate cast with the implant analogs.

### 3. RESULTS

Table I shows the descriptives of the four sets of readings. The mean distance between the two reference points at baseline was  $2.276 \pm 0.014$ . The mean value obtained after one time sterilization, five times sterilization and ten times sterilization was  $2.291 \pm 0.033$ ,  $2.287 \pm 0.029$  and  $2.29 \pm 0.032$  respectively. Each reading was repeated three times and the mean was taken for analysis. No significant difference was observed between the readings of once sterilized, five times sterilized and ten times sterilized as compared to the baseline readings (Table II).

There was no significant difference in the microscopic values when subjecting the copings and analogs to different levels of sterilization. The microscopic values demonstrated the consistency and the accuracy of the various components even after sterilization.

Table I. Descriptive values of the samples tested at baseline, once sterilized, five times sterilized and ten times sterilized.

	N	Minimum (cm)	Maximum (cm)	Mean (cm)	Std. deviation
Baseline	10	2.262	2.303	2.276	0.014
Once sterilized	10	2.265	2.352	2.291	0.033
Five times sterilized	10	2.264	2.344	2.287	0.029
Ten times sterilized	10	2.265	2.342	2.290	0.032

Table II. Results of *T*-Test on comparing the baseline values with values obtained after one sterilization, five times sterilization and ten times sterilization.

	Std. error mean	95% confidence interval of the difference		<i>t</i>	<i>df</i>	<i>P</i> value
		Lower	Upper			
Pair 1 Baseline-Once sterilized	0.009	-0.036	0.005	-1.736	9.000	0.117
Pair 2 Baseline-Five times sterilized	0.008	-0.029	0.007	-1.363	9.000	0.206
Pair 3 Baseline-Ten times sterilized	0.008	-0.032	0.004	-1.758	9.000	0.113



#### 4. DISCUSSION

According to the present study, it was found that, repeated autoclaving of the implant components (Implant coping and analogs) did not change the accuracy of the impressions made. According to Albrektsson et al.<sup>1</sup> implant failure caused by sterilization methods may occur years after implants are put in function. Alterations in the cellular activity, have also been reported with various sterilization treatments.<sup>13,16</sup> Adequate sterilization of reusable instruments and components is essential to prevent cross contamination between patients. Due to the surgical nature of implant placement, sterilization is of the utmost importance.<sup>3,8,11,14,18</sup>

The use of fixture level impression technique was expected to record only the implant head position rather than both its position and dimensions. Also, impression accuracy was increased by using custom trays since it has been shown that a difference in the thickness of elastomeric impression material in an impression tray could reduce its accuracy.<sup>10</sup> The measurements of the control group did not change significantly, suggesting that the process of analog retrieval and remounting did not influence the dimensions of the analog. In this study, a traditional method of autoclaving was used to replicate the common clinical scenario. No difference was observed in the dimensions of the coping and replica. This *in vitro* experiment indicates that accuracy of the implant impressions is not compromised by sterilizing the implant copings and analogs.

In a review of studies referring to success and failure in osseointegrated implant treatment, Goodacre et al.<sup>9</sup> studied the mechanical and biological problems associated with the dental implant treatment. The authors mentioned prosthesis and abutment screw loosening, implant fracture and fracture of the metal framework and the restorative material used as some of the mechanical problems associated with dental implant treatment. Misfit of components was cited as a possible cause of these complications. A recent study comparing the influence of different implant devices on knee arthroplasty reported significant difference in the surgical accuracy between devices.<sup>15</sup>

polyethylene (PE) tibial components of the unicompartmental knee prostheses (UKP); it has great impact on the post-operative outcome. For this reason, this study adopted the Taguchi method and finite element analysis (FEA) techniques to estimate the impacts on PE components of UKPs with different designs under different surgical errors. From the results of this study, when there was surgical error in conducting MIUKA, tibial components with metal-backed had better performance and the PE tibial components had the smallest degree of wear.

In summary, the sterilizing the implant components did not have any effect on the accuracy of the impressions made. This finding indicates that implant coping and analogs can be safely sterilized without compromising

on the quality of the impressions made. There may be a difference between the experimental settings and actual clinical situations; therefore, caution should be exercised in the interpretation of the study results. Future clinical studies in different populations are indicated to elaborate on the current study findings.

#### Disclosure of Benefit

The authors declare no conflicting interests and the study was not supported/funded by any company.

**Acknowledgments:** The author would like to thank and acknowledge college of dentistry research center (CDRC), College of Dentistry, King Saud University, Riyadh, Saudi Arabia for funding this research project. This study was funded by a research grant (F 1137).

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Received: 23 May 2014. Accepted: 3 April 2014.

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