The Accuracy of Different Types of Silicone Impression Materials and Technique of Implant Supported Restoration

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Abstract: ***Background**: the techniques of impression taking can be made by either a close or open tray impression procedures or by implant level impression technique, this can be achieved by Snap-on procedure which is best described as a hybrid between the two techniques mentioned previously. The aim of the study was to evaluate the accuracy of implant impressions obtained from different types and viscosity of silicone impression materials. (Addition silicone monophase, addition silicone (heavy/light body) and condensation silicone (putty/light body). **Materials and methods**: Two dental implants holes were drilled in the lower lateral incisor in both sides in the lower edentulous cast, two implants fixtures size 12mm/Ø4 of Dentium Company inserted in the drilled holes. Three types of impression technique used and the evaluation of the accuracy of the impression technique with different impression materials were tested. Impression copings were removed and parallelism gauges attached to the implant then CBCT is taken for all casts using SOREDEX CBCT machine. A demand system software measuring the distances between the parallelism gauges in 4 points, the measurements compared by one way ANOVA Table with multiple comparison LSD tests applied. **Results**: Descriptive statistical analysis show that the best result of the dimensional accuracy obtained with monophase A-silicone type impression material when compared with the other types of materials used in the study. **Conclusions**: For impression materials, monophase addition silicone impression material produce more accurate impression than condensation silicone impression material Addition silicone impression material is recommended for implant impression. For impression technique Snap-On impression technique exhibited better three-dimensional transfer compared to open and closed impression technique.The three-dimensional accuracy of Snap-On impression technique was comparable to that of the open-tray technique.The open-tray impression technique exhibited higher accuracy in comparison to closed-tray technique with monophase and heavy bodytype A.*

Keywords: open tray technique, closed tray technique, Snap-On Impression Technique, monophase A-silicone impression material

1. Introduction

Impression is a negative imprint of an oral structure used to produce a positive replica of the structure to be used as a permanent record or in the production of a dental restoration or prosthesis.[1]

In order to accurately related an implant abutment or implant analogue to dental arch other structures the impression should be accurate enough and produce a high details.[2]

Open tray impression procedure considered as a direct impression technique which allow removal of the impression copings completely with impression as the dentist can unscrew the retaining screw of the impression. [3]

While closed tray impression procedure differ from that of open tray one in that the screw retaining the impression coping hidden by the impression materials and the dentist can not unscrew the impression coping. [4]

Another technique which is a hybrid one utilized both previously mentioned techniques named as snap on impression technique. [5]

The impression materials used in implant are usually elastomeric impression materials.[6]whichare (polysulfide, polyether, silicone Impression materials which include condensation silicone and addition silicone in different viscosity heavy body / light body or Monophase.

The aim of the present study was to evaluate the accuracy of implant impressions obtained from different types and viscosity of silicone impression materials. (addition silicone monophase, addition silicone heavy/light body, condensation silicone putty/light body)

2. Materials and Methods

2.1 Sample grouping

Three major groups were prepared from different impression Techniques and they will subdivided according to the materials used in each technique:

Group A: closed tray technique (Monophase A-silicone impression material, Heavy/light body A-silicone type impression material and putty/light body C-silicone type impression materials) (n=10).
Group B: Open tray technique(Monophase A-silicone impression material, Heavy/light body A-silicone type impression material and putty/light body C-silicone type impression materials) (n=10).
Group C: Snap-On Impression technique (Monophase A-silicone impression material, Heavy/light body A-silicone type impression material and putty/light body C-silicone type impression materials) (n=10).

2.2 Reference Casts Preparation

A surgical engine with torque of 40 N and speed of 800 RPM with the aids of Dentium company surgical kit were used to drill a hole of 12mm in simulated cast.Two dental implants holes were drilled in the lower lateral incisor in both sides in a lower edentulous cast (reference cast), 2 implants or fixtures size 12mm/Ø4 of Dentium Company inserted in the drilled holes. 10 reference casts were prepared (fig.1).

Figure 1: Reference cast with 2 implants

3. Impression Techniques

A. Closed tray technique

Two Impression copings size 15mm/Ø4.5 attached to the fixture with the smooth surface of coping facing labially, and tightening the screw of the impression coping using screw driver[5] (fig.2)

Figure 2: Impression closed tray copings in reference cast

B. Impression taking

Monophase A-silicone impression material
The Monophase A-silicone impression material is mixed in automatic mixing machine, then part of the material loaded in syringe to act like light body and part loaded into the impression tray to act like heavy body (fig.3).

Figure 3: Monophase A-silicones in tray and syringe

The monophase impression material is injected over the impression copings then the tray with material loaded over it till the materials set (fig.4).

Figure 4: Impression tray loaded over impression copings

After that the material set and removed from the model, the impression copings unscrewed to remove them from the implant. The impression copings placed back into position in the impression material after analogues screwed to it prior to pouring the stone model[4](fig.5).

Figure 5: Monophase A-silicone impression

Heavy body/light body A-silicone
Heavy body A-silicone is mixed by mixing machine then loaded into the tray. Light body is mixed with dispenser and injected over the impression copings then impression is

taken,continue as previous in steps applied in monophase A-silicone impression technique.

Putty/Light body C-silicone
Putty C-silicone is mixed with equal volume using measuring spoon, then loaded on the tray. Equal length of light body C-silicone and catalyst are dispensed on the mixing pad, mixed until obtain a homogenous mixture and loaded over the impression copings and impression is taken, then Continue as previous steps applied in monophase A-silicone impression technique.

C. Open tray technique

Preparing for impression
Two coupes for open tray technique attached to the implant and tightened the screw to secure the coupes to the implant.The screw holding the coupes on the implant is accessed through holes in the tray. [3](fig.6).

Figure 6: Open tray technique the screw holding the coupes on the implant is accessed through holes

Impression taking

Monophase A-silicone impression material
Repeat steps number appliedwith closed tray impression technique, then unscrewed to allow removal of the impression.The impression coupes remain fixed in the impression material and the implant analog is connected to the transfer coupes prior to pouring the stone.

Heavy body/light body A-silicone
Similar to that of previously mentioned steps applied in monophase A-silicon impression technique and heavy body/light body A-silicone in closed tray impression technique.

Putty/light body C-silicone
Similar to that of previously mentioned steps applied in monophase A-silicon impression technique and putty/light body C-silicone in closed tray impression technique.

D. Snap-On direct impression technique

Preparing for impression
Implant abutment size (Ø4.5/1) for DentiumCompany attached to implant in the model, the direct transfer coping “snaps-on” inserted to the top of the implant abutment in the model and tighten the screw of the abutment to secure the abutment in its position (fig. 7).

Insert the direct transfer coping “snaps-on” to the top of the implant abutment in the model[5] (fig. 8).

Impression taking

Monophase A-silicone impression material
Repeat steps applied in closed tray impression technique taking. The set impression is removed from the model; the implant analog is connected to the implant abutment and reinserted to the snaps-on that remain in the impression prior to pouring the stone model (fig. 9 and 10).

Heavy body/light body A-silicone
1-Repeat steps applied in closed tray impression technique taking andrepeat steps applied insnaps-on tray technique monophase A-silicone impression material.

Putty/light body C-silicone
Repeat steps applied in closed tray impression technique taking and repeat steps applied in snaps-on tray technique monophase A-silicone impression material.

Figure 7: Implant abutments attached to the implant

Figure 8: Transfer coping “snaps-on” to the top of the implant abutment

Figure 9: transfer coping “snaps-on” becomes embedded in the impression

Figure10: Implant abutment with the analog in the impression

Pouring the impressions

For the three types of impression materials and technique after impressions were taken, analogs attached to impression coupes and/or abutments as they were first inserted in the reference cast.

Then dental stone is mixed and poured into the impression using boxing technique after the stone was set impression were opened.

10 casts were produced from each impression material type, a total for each impression technique will be 30 casts and for total impression technique and impression materials 90 casts produced.

Distance measurements using CBCT

Impression copings were removed and parallelism gauges attached to the implant then CBCT is taken for all of the casts using SOREDEX CBCT machine, using ONDEMAND system software to measure the distances between the parallelism gauges in 4 points (AB, DC, AC, BD) (fig 11, 12 and 13).

Figure 11: CBCT to the implant and parallel guide

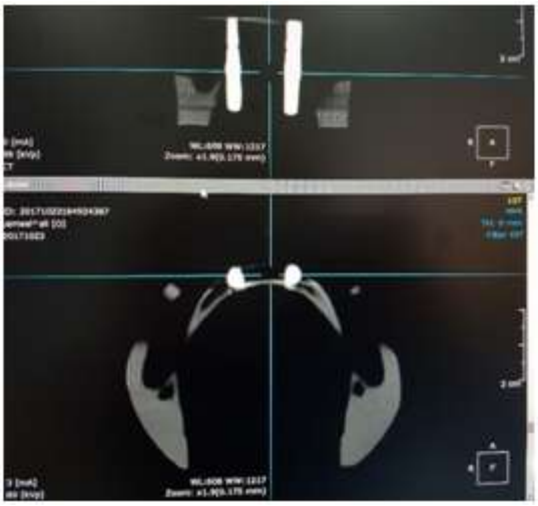

Figure 12: Tope view of the parallel guide

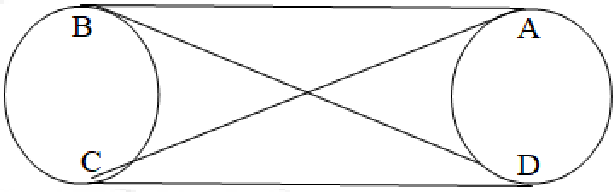

Figure 13: measuring points on the parallel guide

Statistical analysis

Data were collected and analyzed using SPSS program version 21.0. The descriptive statistics included means, standard deviations while the inferential statistics included one way ANOVA test and LSD multiple comparison test.

4. Results

The result in table1 shows descriptive statistics of all type of impression material (Monophase A-silicone impression materials, Heavy/light body A-silicone type impression material, and putty/light body C-silicone type impression materials) by using three different technique (closed tray, open tray and snap on impression technique) for each material.

The results show that the best accuracy obtained by using monophase A-silicone type impression material than other material with mean value (18.87mm, 18.88mm, and 18.90mm) compared with control group with mean value (18.90mm).

Table 1: Descriptive Statistics of (Monophase A-, Heavy/light body, putty/light body) C-silicone type impression materials by use 3 different technique.

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CO	10	17.50	18.90	18.2150	.16211	.51265
MO	10	17.42	18.87	18.0555	.15410	.48730
MC	10	17.44	18.88	18.1380	.15403	.48708
MI	10	17.45	18.90	18.2028	.15496	.49001
HAO	10	17.42	18.80	18.1153	.16227	.51315
HAC	10	17.44	18.88	18.1303	.16583	.52439
HAI	10	17.45	18.90	18.1768	.16098	.50907
HCO	10	17.15	19.07	18.1430	.21928	.69341
HCC	10	17.53	18.99	18.2805	.18298	.57863
HCI	10	17.53	19.07	18.2823	.17237	.54507

The inferential statistical results (ANOVA and LSD test) between different groups are highly significant as shown in table 1, 2 and 3.

Table 2: Open tray technique ANOVA test between control group and different material groups (Monophase A-, Heavy/light body, putty/light body) C-silicone type impression materials

ANOVA								
LSD OPEN TECH.								
		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		F	sig
					Lower Bound	Upper Bound	.061	.941
MO	HAO	-.05975-	.25581	.817	-.5846-	.4651		
	HCO	-.08750-	.25581	.735	-.6124-	.4374		
HAO	HCO	-.02775-	.25581	.914	-.5526-	.4971		

Table 3: Closed tray technique ANOVA test and LSD between control group and different material groups (Monophase A-, Heavy/light body, putty/light body) C-silicone type impression materials

ANOVA								
LSD CLOSED TECH.								
		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		F	sig
					Lower Bound	Upper Bound	.253	.778
MC	HAC	.00775	.23763	.974	-.4798-	.4953		
	HCC	-.14250-	.23763	.554	-.6301-	.3451		
HAC	HCC	-.15025-	.23763	.533	-.6378-	.3373		

Table 4: Snap on impression technique ANOVA test and LSD between control group and different material groups (Monophase A-, Heavy/light body, putty/light body) C-silicone type impression materials

ANOVA								
LSD MI TECH.								
		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		F	sig
					Lower Bound	Upper Bound	.114	.893
MI	HAI	.02600	.23042	.911	-.4468-	.4988		
	HCI	-.07958-	.23042	.732	-.5524-	.3932		
HAI	HCI	-.10558-	.23042	.650	-.5784-	.3672		

The Correlation between control group and different material groups (Monophase A-, Heavy/light body, putty/light body) C-silicone type impression materials show a highly significant result as shown in table 5.

Table 5: Correlation between control group and different material groups (Monophase A-, Heavy/light body, putty/light body) C-silicone type impression materials

		CO	MO	MC	MI	HAO	HAC	HAI	HCO	HCC	HCI
CO	Pearson Correlation	1	.948**	.992**	.994**	.992**	.977**	.991**	.912**	.874**	.888**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.001	.001
	N	10	10	10	10	10	10	10	10	10	10
MO	Pearson Correlation	.948**	1	.979**	.955**	.928**	.919**	.973**	.880**	.857**	.823**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.001	.002	.003
	N	10	10	10	10	10	10	10	10	10	10
MC	Pearson Correlation	.992**	.979**	1	.992**	.979**	.967**	.995**	.913**	.864**	.867**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.001	.001
	N	10	10	10	10	10	10	10	10	10	10
MI	Pearson Correlation	.994**	.955**	.992**	1	.986**	.975**	.994**	.931**	.852**	.876**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.002	.001

	N	10	10	10	10	10	10	10	10	10	10
HAO	Pearson Correlation	.992**	.928**	.979**	.986**	1	.994**	.980**	.931**	.897**	.916**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000
	N	10	10	10	10	10	10	10	10	10	10
HAC	Pearson Correlation	.977**	.919**	.967**	.975**	.994**	1	.969**	.925**	.899**	.922**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000
	N	10	10	10	10	10	10	10	10	10	10
HAI	Pearson Correlation	.991**	.973**	.995**	.994**	.980**	.969**	1	.922**	.878**	.877**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.001	.001
	N	10	10	10	10	10	10	10	10	10	10
HCO	Pearson Correlation	.912**	.880**	.913**	.931**	.931**	.925**	.922**	1	.867**	.900**
	Sig. (2-tailed)	.000	.001	.000	.000	.000	.000	.000		.001	.000
	N	10	10	10	10	10	10	10	10	10	10
HCC	Pearson Correlation	.874**	.857**	.864**	.852**	.897**	.899**	.878**	.867**	1	.934**
	Sig. (2-tailed)	.001	.002	.001	.002	.000	.000	.001	.001		.000
	N	10	10	10	10	10	10	10	10	10	10
HCI	Pearson Correlation	.888**	.823**	.867**	.876**	.916**	.922**	.877**	.900**	.934**	1
	Sig. (2-tailed)	.001	.003	.001	.001	.000	.000	.001	.000	.000	
	N	10	10	10	10	10	10	10	10	10	10

**. Correlation is significant at the 0.01 level (2-tailed).

5. Discussion

To achieve a stress -free implant supported prosthesis the abutment analogues on the working casts must relate in the same manner as the implant abutments intra-orally. Thus accurate impression taking and cast forming, are primary factors in ensuring precise fitting of the final prosthesis. If the framework is not passively seated, it could be sectioned and reassembled, but this is time consuming and results in a weaker and more complex prosthetic framework

Studies comparing the accuracy of implant impression techniques with methods such as micrometers, Vernier calipers, strain gauges, or measuring microscopes could merely carry out two-dimensional measurements.[9, 10, 11, 12, 13]

After analyzing the results, cast reproduced from addition silicone were more accurate than those produced from condensation silicone this was interpreting results as condensation silicone has less dimensional stability because of the high curing shrinkage due to evaporation of the ethyl alcohol byproduct[14].

More accurate casts obtained from monophase A-silicone than heavy/light A-silicone, this may be due to the fact that heavier consistency materials tends to push lighter material from the critical areas and the light body may ends up either in a lingual or Buccal areas, this in agreement with Milar [15], also in agreement with Hoods-Moonsammy et al in 2014 who found similar results when using (Aquasil Monophase and Aquasil putty with light-body wash, DENTSPLY), a polyether and impression plaster[16]. While disagree with Prithviraj et al in 2011 who found that accurate manipulation of any materials will give the same results and the same accuracy and reproduction of details [17].

In light of various options available for impression making, an understanding of which method offers the most precise result is needed. A variety of factors have an influence on the precision of each impression technique, including flawless manipulation of impression materials, the materials used for impression making, the materials used for pouring dental stone, and appropriate timing of cast fabrications[18,19,20].

The results of this study indicated that among the, Snap-On technique had the highest accuracy, comparable to the open-tray and closed-tray impression techniques. Thus, the null hypothesis indicating no difference between the different impression techniques for dental implants was rejected.

It has been demonstrated that the shape and geometry of the metal impression coping could affect the accuracy of the open-tray impression technique[21].

In the current study, the impression copings were nearly similar in terms of length, width and indentation depth, which might explain why no difference was detected in the accuracy of the open-tray technique in the implant systems studied. It is true that different results might have been obtained if nonparallel implants had been employed since internal connections of the systems evaluated were not identical, and this would have resulted in different distortions during impression removal [22].

To date, several studies have evaluated the accuracy of the Snap-On technique.[23, 24,25,26,27]

Akça and Cehreli[15] found that the angular and positional accuracy of the Snap-On closed-tray technique with stock tray and vinyl polysiloxane impression material were similar to the open-tray and same impression material[28]. Also reported similar or even less three-dimensional displacement for the Snap-On technique in comparison to the direct technique.

Removing the transfer coups together with the impression in the Snap-On technique will give a more accurate positioning of the analog and subsequently minimizing errors [29, 30].

Some dentists prefer to place abutments and then make the impression in the same manner that an impression is made for natural teeth. This latter impression technique necessitates recording of positions and dimensions, rather than the implant level impression method (open and closed technique), which requires only recording of the implant the adposition. Both of these factors suggest that displacement of impression coping was likely to have less of an effect than in Snap-On impressions technique Other factors that appear to play an important role in the accuracy of the this impression technique in many implant systems are tactile sensation and the snap mechanism that indicates proper seating. It is likely that in some cases, the dentist does not feel that the transfer coping of open and closed technique is properly seated. These results are in agreement with those of Daoudi's study, in which the author concluded that abutment level impression technique produced less in accuracy, his study design and materials were different. Daoudi attributed these results to differences between picking the impression coping up and repositioning the coping in the impression. However, the impression coping shape of that study was different; also, abutment level and implant level copings were metallic rather than plastic. Moreover, Daoudi compared the pick up impression technique (abutment level) with there positioning impression technique (implant level) and did not evaluate 2 pickup (direct) impression techniques at implant and abutment levels.[31]

Multiple dental implant impression will increase the possibility of errors during the transfer procedure of the copings especially when facing different dental implant angulation situation [32].

Lee et al in found that the accuracy of all impression techniques used with dental implant have no significant results when comparing the level of details productions and examined clinical factors.

6. Conclusion

For impression materials

Addition silicone impression material produce more accurate impression than condensation silicone impression material, in addition; monophase addition silicone impression material produce more accurate cast than heavy body/light body Addition silicone impression material, so that addition silicone impression material is recommended for implant impression.

For impression technique

Within the limitations of this study, the Snap-On impression technique exhibited better three-dimensional transfer compared to open and closed impression technique, in addition; the three-dimensional accuracy of Snap-On impression technique was comparable to that of the open-tray technique.The open-tray impression technique exhibited higher accuracy in comparison to closed-tray technique with monophase and heavy body A type.

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