***ISSN:* 1812–1217**

Dimensional accuracy of impression techniques for the endosteal implants (An in vivo study): Part II

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ABSTRACT

Aims: To determine the most accurate impression techniques and materials to transfer the exact position of a single implant to stone die to construct the prosthesis for selected clinical cases. **Materials and methods:** Five clinical cases were selected with special criteria to construct implant (Frialit–2) prosthesis on a stone die with high accuracy according to the results of study. Four impression techniques were used (direct and indirect, each with one and two steps) using condensation, addition (heavy, medium and light consistencies) silicone impression materials. Ten impressions were taken for each patient to produce a total number of 50 stone casts. The direct and indirect measurements were performed by using digital vernier. **Results:** The significant differences between the impression techniques at the three axes of dimensions ($p \leq 0.05$) were applied clinically to construct the fixed prosthesis for each patient. The results of this study showed that the high dimensional change of laboratory cast was related to indirect one step impression technique to transform the implant position from patient mouth to laboratory cast. Addition curing (medium consistency) silicone impression material produced the lowest accurate stone die. **Conclusions:** The results of this study showed that the direct two steps impression technique was the accurate impression technique for transformation of implant position from patient mouth to laboratory cast. Additional curing (light and heavy consistency) silicone impression material produced the most accurate stone die and gave a successful treatment to the patient.

Key words: Endosteal implant, in vivo study, accuracy of impression.

Hatim NA, Al–Mashaiky BM. Dimensional Accuracy of Impression Techniques for the Endosteal Implants (An in vivo study): Part II. *Al–Rafidain Dent J*. 2007; 7(2): 131–137 .
Received: 18/12/2005 ***Sent to Referees:*** 21/12/2005 ***Accepted for Publication:*** 13/2/2006

INTRODUCTION

The major objective in making implant supported prosthesis is the production of superstructure that exhibits a passive fit when connected to multiple abutments.[1]

Accurate impression and working casts are essential for conventional prosthodontic procedures on natural abutment. The transfer of the exact position of the implants to the working cast is perhaps even more critical, because the implants lack the mobility of the natural teeth. Failure to meet this objective can result in a loss of fixture integration and progressive treatment failure. Forced tightening of the sup-erstructure can also result in micro fracture of bone, a zone of marginal ischemia, and healing with a non mineralized attachment to the implant fixture.[2, 3] Adequate stress distribution may also encourage the main-tenance of marginal bone, close to the implant fixture.[4]

Impression techniques for dental implants to transfer the implant location prior to fabrication of prosthesis mainly classified into direct (open–tray) technique and indirect (closed–tray) technique.[5] Those techniques have been investigated with varying results.[6–8] Many modifica-tions were suggested for these techniques to increase precise relation of the transfer copings to each other.[9, 10]

The accuracy of an impression material plays an important part in the pro-duction of a well–fitting restoration and thus for the longevity of the restoration.[11, 12] Thus the impression must be stable enough to produce accurate cast over extended periods of time. This needs more stable, accurate and elastic impression material

which sponsored the introduction of Elastomers into dentistry.[13, 14]

The aims of this study were to apply different type of impression techniques with different silicone impression.

MATERIALS AND METHODS

Five clinical cases were selected with successful surgical treatment (after 6 months) of single implant FRIALIT–2 system in the anterior segment prepared for prosthetic stage to facilitate the use of vernier to record direct measurements in the oral cavity.

Ten impressions were taken for each clinical case using different techniques (as in Part I): Direct (open tray) one step technique, Direct two steps with spacer, Indirect (close tray) one step, and Indirect two step; The three types of impression materials (Ormadent Condensation Major Italy and President Addition Silicone Colten, Switzerland Light Body and Putty Type, Perfexil Addition Silicone Septodont France Medium Body) were used to produce fifty impressions that when poured with Silky Rock dental stone according to manufacture instructions they produced fifty stone casts (Figure 1). For the medium body two techniques only used (Direct one step, and indirect one step).

Stock tray was selected for each patient according to his need. A certain modification one opening according to the position of the implant for each clinical case was performed to the tray to facilitate the use in the open tray impression technique.

After two weeks of placement of gingival–forma, the patient was prepared to take 10 impressions by using Prosthetic implant parts of Frialit–2 system (Figure 2).

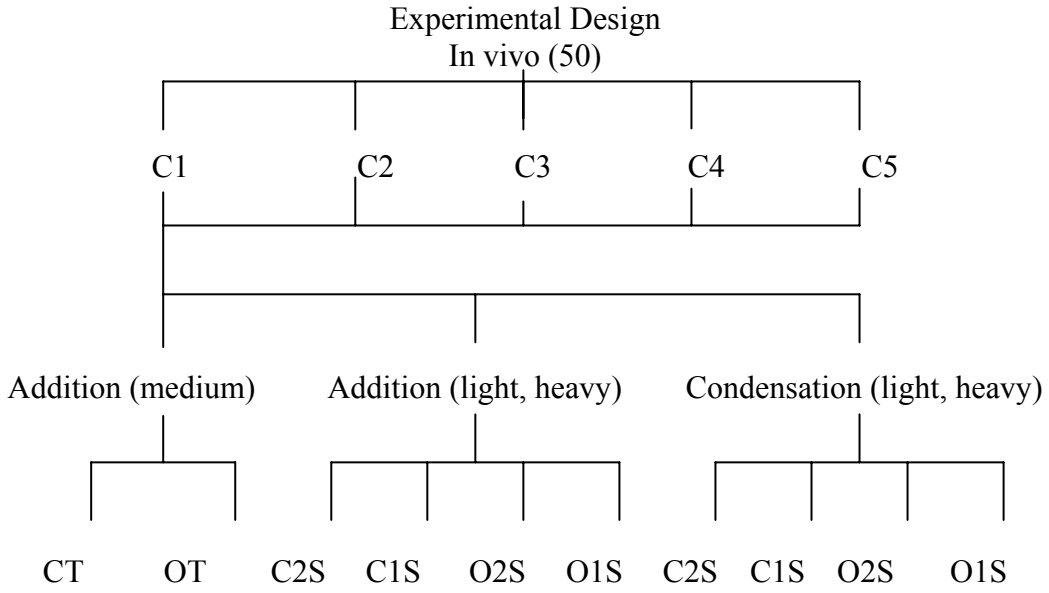

Figure (1): Experimental design in vivo

C1, C2, C3, C4, C5: The number of five clinical cases; CT: Close Technique; OT: Open Technique; C1S: Close one step technique; C2S: Close two steps technique; O1S: Open one step technique; O2S: Open two steps technique.

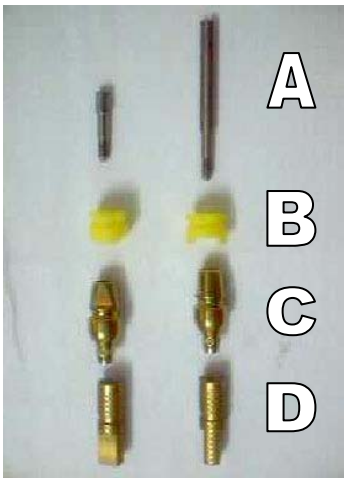

Figure (2): Prosthetic implant parts of Frialit–2 system
A: Abutment screw (short & long); B: Plastic cap; C: Transfer coping; D: Implant analog.

The measurements can be obtained by using digital vernier directly from the patient mouth after fixing the patient's head to the headrest of the dental chair in a situation that insure the parallelism between the occlusal plane with the floor by using fox bite to get this situation (Figure 3). Certain reference points were detected on the occlusal plane in order to obtain the measurements of the three axes X, Y and Z. This reference points were detected according to each case separately, that's to say each clinical case have its own reference points on the occlusal plane that differs from another case.

These measurements were to compare with the measurements performed on the stone dies which have been resulted from impressions taken from the patient's mouth by four techniques mentioned before. The measurements on stone dies should depend on the same reference points, used in the patient's mouth for each case. As a result of this comparison the accuracy of these stone dies in relation to the control group were detected (patients mouths) and we can select the most accurate technique and material used.

Statistical methods (Descriptive, One sam-ple T–test, ANOVA, and Duncan's Multiple Range Test) were used in order to analyze and assess the results.

Figure (3): Digital vernier used to measure X, Y, and X axes.

RESULTS

Results obtained from an in vivo study: Five clinical cases were used for obtaining the measurements of 50 stone casts by using digital vernier only due to inability to use the optical microscope intra orally.

Analysis of variance (ANOVA) of dimensional accuracy of stone casts resulted from using four impression techniques were performed to find if there was any significant difference between different levels of variables. The results in Table (1) showed that there was a significant difference between these impression techniques.

Duncan's multiple range test was performed to detect the most perfect impression technique for the transformation of the implant position to the laboratory cast. The results in Table (2) and in Figure (4) showed that the open tray two steps impression techniques is the best one.

Analysis of variance (ANOVA) for the dimensional accuracy of stone casts resulted from using three brands of silicone impression materials that involve: Condensation curing, addition curing 'monophase' and addition curing 'two phase', was performed to find if their was a significant difference between different level of variables. The results in Table (3) showed that their was a significant difference between most of the variable levels.

Duncan's multiple range test was performed to detect the most accurate impression materials used in dental implants. The result in Table (4) and in Figure (5) showed that the addition curing 'two phase' impression materials was the best impression materials used in dental implant.

Table (1): Analysis of variance (ANOVA) for stone casts produced by using four impression techniques (in vivo).

Source of Variation	SS	df	MS	F–value	*P*–value
Techniques–X	3.907	3	1.302	3.050	≤0.05
Error	15.373	36	0.427		
Total	19.280	39			
Techniques–Y	48.149	3	16.050	3.343	≤0.05
Error	172.825	36	4.801		
Total	220.974	39			
Techniques–Z	68.426	3	22.809	3.108	≤0.05
Error	264.190	36	7.339		
Total	332.617	39			

SS: Sum of square; df: Degree of freedom; MS: Mean of square.
$p>0.05$ = Not significant, $p\leq0.05$ = Significant, $p<0.01$ = high significant, $p\leq0.001$ = very high significant

Table (2): Duncan's multiple range test for measurements of stone casts produced by four impression techniques (in vivo).

Technique	Step	X mm		Y mm		Z mm	
		Mean ±SE	Range	Mean ±SE	Range	Mean ±SE	Range
Closed	**One**	1.02 ± 0.24 b	0.14–2.31	3.31 ± 0.85 b	0.27–7.95	3.38 ± 1.03 b	0.50–10
	Two	0.42 ± 0.21 ab	0.02–0.63	1.30 ± 0.24 ab	0.42–2.33	0.65 ± 0.14 a	0.22–4
Open	**One**	0.88 ± 0.19 b	0.20–2.04	3.38 ± 0.71 b	0.36–7.0	4.09 ± 0.92 b	0.56–8.88
	Two	0.24±0.07 a	0.02–1.4	0.94 ± 0.32 a	0.08–2.81	1.82±0.46 ab	0.12–1.37

Mean with different letters vertically has significant difference at $p \leq 0.05$.

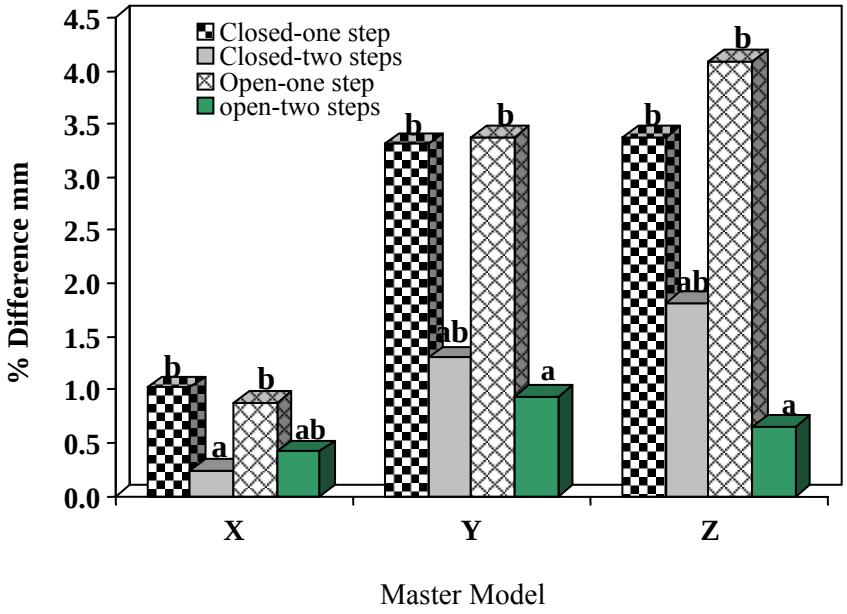

Figure (4): Mean difference of stone casts produce by four impressions techniques in relation to intra oral measurements

Table (3): Analysis of variance (ANOVA) for stone casts produced from using three brands of silicone impression materials (in vivo).

Source of Variation	SS	df	MS	F–value	*P*–value
Materials–X	13.744	2	6.872	45.928	≤0.001
Error	5.536	37	150		
Total	19.28	39			
Materials–Y	164.415	2	82.208	53.780	≤0.001
Error	56.558	37	1.529		
Total	220.974	39			
Materials–Z	191.346	2	95.673	25.058	≤0.001
Error	141.271	37	3.818		
Total	332.617	39			

SS: Sum of square; df: Degree of freedom; MS: Mean of square.
$p > 0.05$ = Not significant, $p \leq 0.05$ = Significant, $p \leq 0.01$ = high significant, $p \leq 0.001$ = very high significant.

Table (4): Duncan's multiple range test for measurements of stone casts produce by three impression materials (in vivo).

Material	Mean Difference± SE mm					
	X	Range	Y	Range	Z	Range
Condensation	0.64 ± 0.13 b	0.02–1.87	1.66 ± 0.28 a	0.27–4.31	2.38 ± 0.52 a	0.56–8.38
Medium	1.80 ± 0.14 c	1.15–2.31	6.49 ± 0.51 b	4.25–7.95	6.93 ± 1.10 b	1.7–10.0
Addition	0.20 ± 0.03 a	0.02–0.48	1.24 ± 0.31 a	0.08–4.74	0.99 ± 0.20 a	0.12–2.63

Mean with different letters vertically has significant difference at $p \leq 0.05$

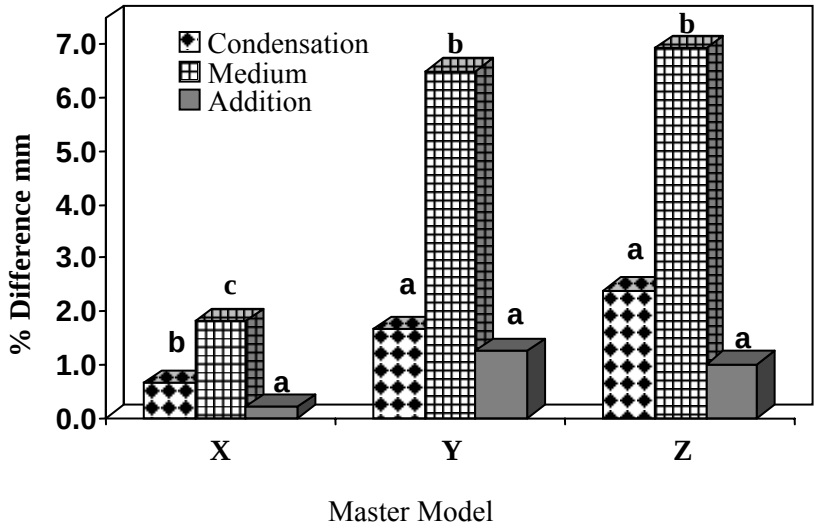

Figure (5): Mean difference of stone casts produce by three Impression materials in relation to intra oral measurements.

DISCUSSION

In this part of study the results were obtained from the measurements of the digital vernier only due to inability to use the optical microscope intra orally; To facilitate the correct application of the digital vernier inside patient mouth, single implant cases of anterior segment was selected clinically. Because there were no previous studies related to the impression techniques accuracy of dental implant in vivo, there were difficulties to agreed or disagreed with the results of other study.

Table (1) showed significant differences between the impression techniques at the three axes of dimension ($p \leq 0.05$). The results of an in vivo study showed that the direct (open tray) two steps impression technique was the most accurate impression techniques (0.65±0.14) in relation to one step impression technique [15], as seen in Table (2) and Figure (4). Table (3) showed highly significant difference between these three impression materials while Table (4) and Figure (5) showed that the addition impression material was the most accurate impression materials (0.20±0.03).

In this study, the results obtained were in the same direction of the results obtained in vitro study, which was in agreement with other studies[16–20] but with slight difference in Z axis from in vitro study (Part I) as showed in Table (2). This may be due to carrying digital vernier directly by operator hand with out using dental surveyor (which can not be used intra orally), also it may be due to the presence of soft tissue intra orally at the site of reference point instead of hard fixed reference point at hard tissue.

CONCLUSIONS

Two steps (putty & wash) impression technique provides positive advantages to the cast accuracy than one step impression technique. The addition curing (putty & light body) silicone impression material is the more accurate impression material for dental implants than medium type.

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This work was done in partial fulfillment of requirements for the degree of MSc by ABM and supported by the university of Mosul and Al- Salam hosiptal