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ORIGINAL ARTICLE

Accuracy of Implant Abutment Level Impression with and without Impression Coping

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ABSTRACT

Aim: Transferring an accurate copy of the patient's soft and hard tissue to the dental laboratory is of essential importance. Various methods of implant impression have different outcomes on dimensions of final cast. This study aimed to compare two methods of implant impression on abutment level with and without impression coping on two parallel implants.

Materials and methods: In this experimental study, a resin model with two holes for fixing the implant was made. The first and second implants had a 4 and 11 mm distance to canine respectively. In this study two methods were used for impression: first was direct (without impression coping) and second was indirect (with the impression coping). Ten impressions were prepared for a total of 10 stone casts. For analyzing the abutment analogs positions, each cast was analyzed using a cruicial malformation and malarticulatoin (CMM) in three dimensions (X, Y, and Z). The difference in dimensions of final casts and laboratory models were analyzed using Independent t-test.

Results: The results did not show a significant difference between direct and indirect methods in Z and Y axis in absolute transmission (Δr). The dimensional changes in the X-axis in the direct method was 0.647 ± 0.155 which is 0.067 ± 0.146 more than the indirect method. A significant difference (p = 0.044) was observed between the two methods in X-axis.

Conclusion: Based on the results, this research found the indirect impression on abutment surface to be more accurate than the direct one. In general, two methods were not significantly different, and dentists can use the simple method of the direct impression for making implant prosthetics.

Clinical significance: Reconstruction of implant's accurate position in the process of impression, along with a tension-free insertion, is the first step in having an accurate prosthesis. Abutment level impression with the impression coping is slightly more accurate than the one without impression coping.

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INTRODUCTION

Implantology has become an inseparable part of dentistry in the past decades by helping dentists to improve the quality of life for a considerable number of patients. In some instances, it is the sole treatment plan for severe functional, anatomic, and esthetic problems resulting from tooth loss.[1]

By comparison, natural teeth are restrained in alveolar bone by periodontal ligaments, but this is not true for implants.[2] Unlike natural teeth, osseointegrated implants do not have any periodontal ligament and show minor mobility resulting from bone tissue elasticity.[3,4] Registering the position of three-dimensional (3D) prosthesis supported by implants is more important than the ones supported by teeth so that a more precise position in final cast would be guaranteed.[5-7] It is completely accepted nowadays that unfitting of prosthetics would increase the possibility of mechanical problems such as occlusal discrepancies, screw loosening of implant or abutment, fracture of a prosthesis or implant components.[6,8,9]

A tension free insertion of prosthetics in regard to implants and abutments is of utmost importance for having a high degree of certainty and predictability of treatment.[10]

For transferring the implant position to a laboratory, several impression methods have been available, one of which is to categorize them in two groups of fixture level and abutment level. Fixture level impression can be done in two forms: first, open-tray or pick-up which keeps the

impression copings in place when the impression is taken out of the mouth. Second, closed-tray or transfer method which leaves the impression copings on the implant and later will be taken off and replaced in place. Similarly, the abutment level method can be done in two forms of direct and indirect.[11]

Out of different methods of impression, an abutment-level method is more interesting due to being easier and having less stages. Advantages of this method are simpler impression procedure and less dependence on the dental laboratory for choosing the abutment.[12]

In the direct abutment level impression, implant abutment can be reconstructed like a natural tooth. Through this way, titanium abutment is screwed on the implant body with final torque, and abutment is impressed inside the mouth after being milled. Then, cast is poured and specific die abutment is created. This method is also called, direct prosthetics method.[1]

In the indirect abutment level impression, the procedure is done by using impression coping. After choosing the abutment and applying final torque, plastic impression copings are put on the abutments so that a "click" sound is heard. In this method, an impression coping remains in the impression until the final cast is poured and detached from the impression.[1]

In a previous research, Alikhasi et al. evaluated the dimensional accuracy of impression techniques on levels of implant and abutment along with its effect on lack of marginal integrity. They concluded that the impression method affects its accuracy.

Moreover, implant level methods are more accurate for creating a 3D implant position in the impression made with polyether impression material.[13]

In another study regarding the dimensional accuracy of impression techniques in endosteal implants, Al-Mashaiky and Hatim had a comparison of different methods for finding the best material and most precise method for transferring one or more implant positions from the main model to die-stone using two methods of measurement. They found the two-step direct impression technique and additional impression material to be the best. The number of dental implants did not have a significant effect on accuracy and correctness of stone cast.[14]

The purpose of this study was to compare two methods of implant impression on abutment level with and without impression coping on two parallel implants.

MATERIALS AND METHODS

A mandibular resin model with partial edentulism in the region of the first premolar to the second molar in the right, and also the left second molar was made. On the main model in the posterior edentulous area and in the implant placement area, a flat surface with an accuracy of 0.001 was created by CNC (Tornos, Germany) so that it would be used for measuring Z axis. Computer software with the help of this landmark, which was repeated in all of the impressions, provided the location of reference implant analog center in null position (X, Y, Z = 0) and by passing a hypothetical plate through this surface and reference implant determined the spatial position, the center of the next implants. By using an acrylic bur, two holes with a diameter of 5 mm and a depth of 4 mm were made in the posterior free end areas (approximately the second molar teeth), so that it would be used as a reference point for drawing X axis on the cast model. Y axis was drawn perpendicularly to X axis on the same plane by computer system attached to coordinate measuring machine (CMM) machine (Fig. 1).

Then, two titanium alloy fixture analog (SSFA 3812, DIO, Busan, Korea), each with a diameter of 3.8 and a length of 12 mm were inserted by dental milling machine along with dental survivor. The distance between the center of the first analog to the canine teeth was at least 4 mm and the second implant had a distance of 11 mm to the canine tooth.

In the next step, to determine the reference surface for measuring and determining the zero point, a flat surface on the canine tooth was determined. In this study, prefabricated plastic trays and additional silicon impression material were used for impression. The abutments used were solid type (SSSA 55305, DIO, Busan, Korea). Before starting the procedure, the abutments were secured on cast model with a force of 30 N/cm. The impressions were made both with impression coping and without it. In this process, impression copings (SSAI 5511, DIO, Busan, Korea) where placed on the first abutment and the second abutment did not have an impression coping, so that the two procedures can be compared (Fig. 2).

The impression in this study was made using a two-stage putty-wash method. Initially, teeth and abutments were covered by an aluminum foil with a thickness of 12 micrometers. Additional silicone impression material

Fig. 1: CMM machine and its control

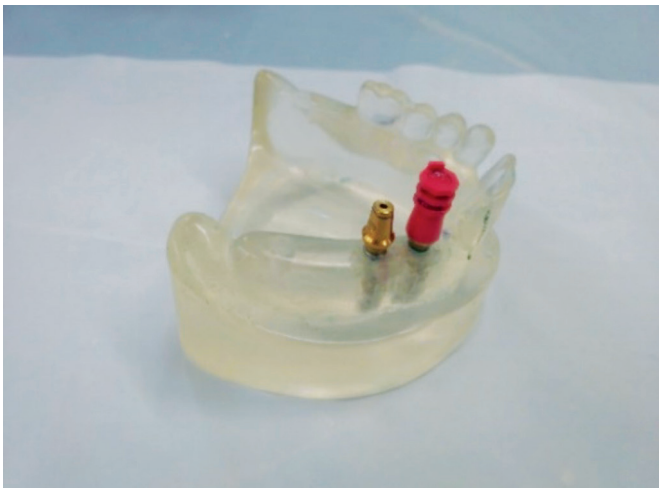

Fig. 2: Model with abutments and impression copping

(Vinyl Polysiloxane, Panasil, Kettenbach, Eschenburg, Germany) with Putty consistency was placed inside the impression tray and two 1 kg weights were used to put a force of 20 N/cm_2 to the tray. After the setting, the impression was removed from the cast and the foil was taken off and the impression was left aside for 24 hours until its dimensional changes completed. The light consistency of additional silicone impression material was injected to the abutments' surrounding by a gun (Dentiann TM-Smart Sil) to the abutment with a coping as well as the abutment without it, and also inside the tray. Then the tray was placed on the model cast until the setting time of the molding material (according to the manufacturer's instructions) was over. Afterwards, the impression material was separated from the model casts (Fig. 3).

Two holes are observed in the impression, which would almost be the same as the closed-tray fixture level impression method. In the first hole which belongs to the abutment with impression coping, an abutment analog (SSAA 5505, DIO, Busan, Korea) was placed (It was done so that its flat surface would be on the lingual side and a "click" sound would be heard which indicates its proper placement in the impression coping). In the second cavity, first a metal rod is placed and gradually filled with a self-cure acrylic resin (Aria Dent, Inlay Pattern resin, Iran) until it would be similar to fixture analog in diameter and height. The impression process was repeated 10 times. For pouring the molds for the preparation of final casts, type 4 stone (Stone Type IV-PADA) was used (Fig. 4).

Afterwards, samples were put inside the coordinate miracle NC-685, China). At first, the stone casts were fixed on a metal plate using a liquid adhesive, and then the operator started moving the device's arm with its handy control. Initially, the measurements were done on the cast models. The four internal walls of the left cavity were touched, and its center was measured and registered on the machine's computer. Then, the same procedure was repeated for the right cavity so a direction would be created for drawing X-axis and it is created from left to right. The Y-axis is drawn perpendicularly to X-axis in the same horizontal plate and in posterior anterior direction. Then, four walls of both abutments were touched by the probe (the contact area was approximately 2 mm below the highest point in each of the abutments). X, Y coordinates were calculated to the left reference hole with coordinates of X, Y = 0. For measuring in Z-axis, the flat surface landmark, which was created in the edentulous ridge, was used. The upper edge of the analogs was touched by the device's probe and two hypothetical plates were created and the machine measured the distance between these two plates as Z dimension which shows the height of analog to the cast. The position of abutments was obtained in three axes and it was used as a reference for the casts in this study. In the obtained plaster casts, the position of analog number 1 (acrylic) and analogue number 2 (titanium)

Fig. 3: Final impression

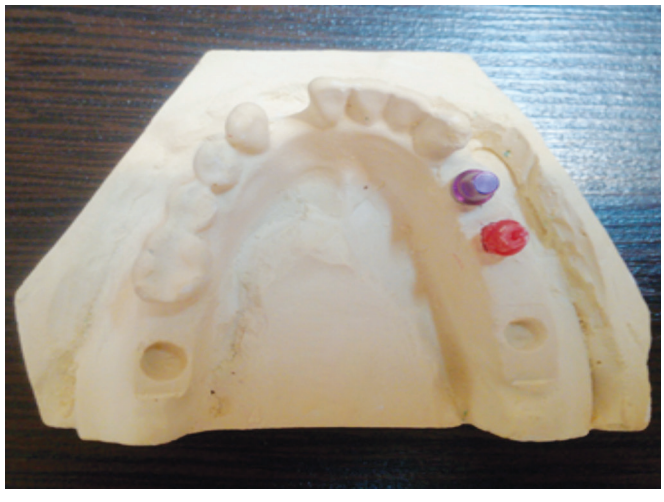

Fig. 4: Cast made with type-4 stone

were calculated and registered based on the method used in cast model (Figs 5 to 7).

After data collection, the information was entered into the software SPSS version 22 and to calculate the movements in millimeters in 3 of X, Y, Z and also, for the total linear movements (Δr) based on r = √x2 + y2 + z2Δ formula, mean and standard deviation statistical indices were used.

For a comparison of these two measurements, at first Kolomogorov–Smirnov test (KS) and distribution normality of measurements were considered. Since the distribution of the measurements follow the normal distribution, parametric independent t-test was used and the significance level of the tests in this study was $p < 0.05$ and two-way meaningfulness was considered.

RESULTS

The variations in X-axis in the method without impression coping with mean and standard deviation was 0.647 ± 0.155 mm and with the impression coping was 0.501 ± 0.145 and this difference was statistically significant. (p = 0.044)

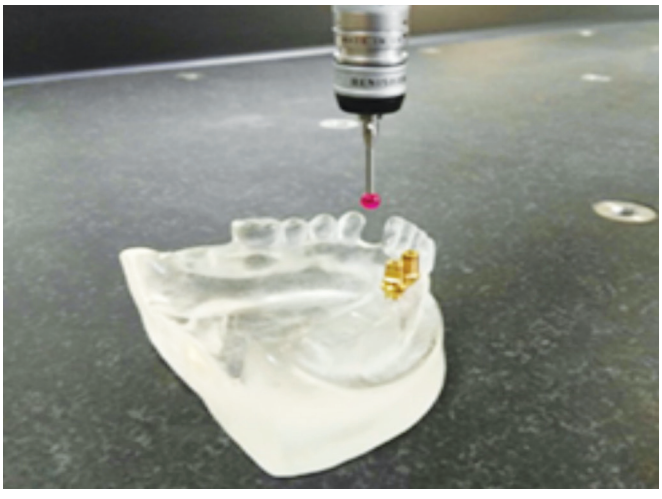

Fig. 5: Probe analyzing the abutments position in reference cast

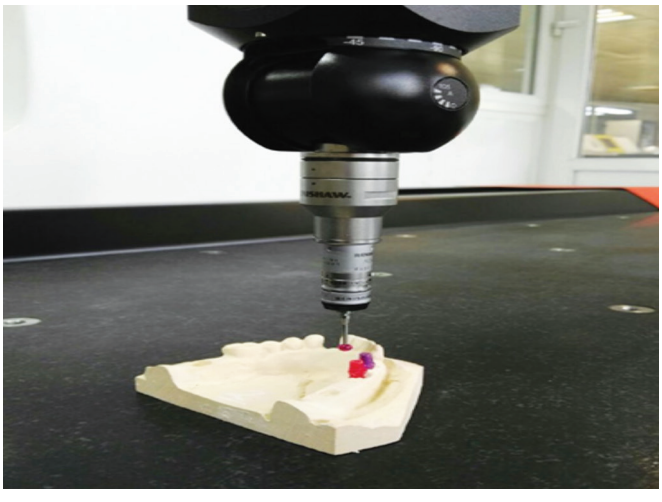

Fig. 6: Probe analyzing the analog abutments position in plaster cast

The change in Y-axis was –0.071 ± 0.128 in the method without impression coping compared to the standard reference. In the method with impression coping the variation was 0.329 ± 0.074 which was not statistically significant (p = 0.213).

In Z-axis, the change in the method without impression coping was –0.246 ± 0.124 mm compared to the standard reference and the impression coping method showed a difference of 0.03 ± 0.453 which is not considered a significant difference (p = 0.091).

In general, infinite dimensional variations in the method without impression coping was 0.238 ± 1.02, and in the impression, coping method was 0.314 ± 1.09 which are not considered statistically significant.

The biggest changes compared to the standard reference in the method without impression coping from left to right was in X, Z, and Y dimensions respectively, but in the impression coping method most significant differences compared to the standard was in X, Y, Z (Table 1).

DISCUSSION

Reconstruction of intra-oral implant position during the impression process is the first step in obtaining accurate prostheses for a tensionless insertion. The critical issue is to register the 3D orientation of implants in the mouth so that it creates details which are necessary for successful treatment of implants prosthesis.[15]

Both polyether and additional silicone are the impression materials which are recommended based on studies regarding implant impressions. Sorrentino et al. found out that additional silicon in the presence of non-parallel Implants showed a more precise result compared to polyether.[16] In another study, Hatim and Al-Mashaiky reported silicon impression material of additional type (with light and heavy consistency) to make the most accurate results in die-stone and provides the most successful treatment for the patients.[14] In the present study, additional silicon impression material with two light and putty consistency were used for an impression.

In the two-step impression procedure, there is a contraction in the impression space which is the

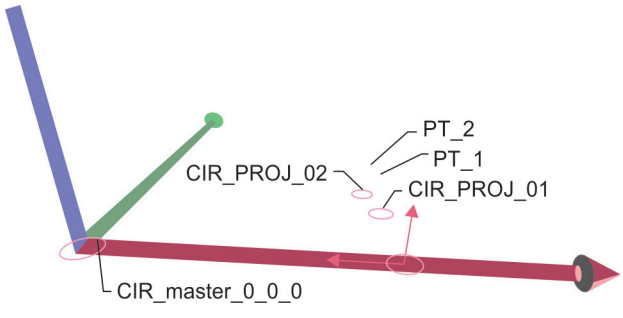

Fig. 7: Computer simulation of graphs X, Y, Z

Table 1: Mean and standard deviation of two groups in X, Y and Z axes

	Group	N	Mean	Standard deviation	p	Mean difference	Standard error	% 95 confidence interval difference	
								Lower	Upper
Variations in X-axis	With impression coping	10	0.06470	0.15485	0.04400	0.146	0.067	0.005	0.287
	Without impression coping	10	0.5014	0.14504					
Variations in Y-axis	With impression coping	10	–0.74	0.128	0.213	–0.144	0.112	–0.379	0.090
	Without impression coping	10	0.74	0.329					
Variations in Z-axis	With impression coping	10.00	–0.246	0.124	0.091	–0.276	0.148	–0.606	0.053
	Without impression coping	10.00	0.030	0.453					
Absolute variations of all axes	With impression coping	10.00	1.023	0.238	0.549	–0.76	0.125	–0.338	0.186
	Without impression coping	10.00	1.099	0.314		–0.76	0.125	–0.339	0.187

consequence of putty volume increase and a result of a mild volume increase of wash contraction. These agree with the results achieved by Al-Mashaiky and Hatim who concluded that the accuracy of casts made in a two-step procedure is higher than the one-step method especially when performed with additional silicon impression material.[14] The great dimensional changes in casts were in connection with one-step indirect impression technic. Based on the mentioned researches, two-step direct impression method is the most accurate impression method for transferring the implant position from patient's mouth to laboratory cast, and two-step impression method (putty-wash) shows positive results in the accuracy of cast in comparison with the one-step technic.

The purpose of this study was to compare two methods of implant impression on abutment level with and without impression coping on two parallel implants. In this method, self-polymerizing pattern resin was used for making the abutment analog. Based on the study by Mojon et al. the dimensional changes resulting in contraction of acrylic resin polymerization would probably affect the results. It has been reported that general shrinkage of acrylic resin would be between 6.5 to 7.9% in the first 24 hours along with an 80% shrinkage happening in the first 17 minutes after mixing. Considering that shrinkage of acrylic would decrease the volume of acrylic analog in the method without impression coping, probably the achieved results by analyzing CMM machine in Y and X dimensions and the observed differences in X-axis in two methods can be due to this.[17]

Jahandide and Pournasiri compared the accuracy of open-tray impression through the method of connection with an acrylic pattern.[18] In that study, four implant fixtures were put vertically on the surface of an acrylic model of the mandible, and the special tray and additional silicone impression material were used for the procedure. In the open-tray method, special impression copings were used for impression, but in acrylic pattern method titanium abutments were used instead of impression copings. The results of that study did not reveal a statistically significant difference between the methods of an impression in deviation from general dimensions of Y and X ($p > 0.05$). but a considerable difference was reported in Z ($p < 0.05$) however. The achieved results suggest that substituting the acrylic with open-tray requires further studies. Similarly, in the current study, solid abutments and mandible casts were used, and the results were alike in the Y dimension but different in Z and X.

Some reasons for the X-axis results can be as follows: volume changes of acrylic analog due to contraction at the time of polymerization, and errors at the time of analog making and its replacement in the made impression. In the method with impression coping, a plastic cap can be an aid for creating required space for placing the analog, but in the direct method (without impression coping) this space would not be created and the volume changes of analogs in the final casts would be unavoidable. Another reason can be the position of first implant in a place posterior to the second implant (impression coping method) which can reduce the accuracy of results.

CONCLUSION

Considering the limitations of the current study, the achieved results can show that abutment level impression with impression coping in X-axis is slightly more accurate than the one without impression coping for registering the position of implant abutment. But in general, it can be concluded that for a 3D positioning of implant abutment in the impression no significant differences were observed between the two methods. It can also be said that in case the dentist would have enough time for abutment milling and having a supragingival finishing line, the simple and common technic of putty-wash can be used for making the implant prosthetics.

CLINICAL SIGNIFICANCE

Reconstruction of the implant's accurate position in the process of impression, along with a tension-free insertion, is the first step in having an accurate prosthesis. abutment level impression with the impression coping is slightly more accurate than the one without impression coping.

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