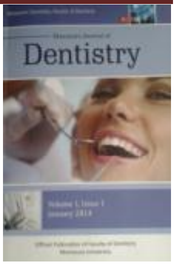
Mansoura Journal of Dentistry 2014;1(3):109-114.



Metal Vs Plastic Copings Regarding the Accuracy of Implant Transfer Impression Techniques: in-Vitro Study

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Abstract:
Objectives: A successful implant restoration can be achieved only when a passively fitting prosthesis is fabricated. The impression must record the soft tissue supporting areas simultaneously with accurate positioning of implant components. Reproducing the intraoral relationship of implants through impression procedures is the first step in achieving an accurate passively fitting prosthesis. This study aimed to evaluate and compare the metal and plastic impression copings regarding the accuracy of indirect implant transfer impression techniques.
Methods: This in vitro study was carried out on acrylic resin model representing a completely edentulous mandibular ridge with four implants installed bilaterally in the canine and first molar areas and soft liner material had been used at the ridge. Using closed tray for impression. Ten impressions for two groups: Group I: impression with metal transfer copings. Group II: impression with plastic transfer copings. The acrylic resin mode and each stone casts were measured using a measurescope.
Results: There was insignificant difference between changes in different distances in horizontal plane for group I (metal coping). There was a significant difference between changes in different distances in horizontal plane for group II (plastic coping). There was insignificant difference between changes in different distances in vertical planes for both groups.
Conclusions: It is possible to conclude that: 1- Regarding the displacement in horizontal plane, the impression transfer metal coping can be considered better than the impression transfer plastic coping. 2- Considerable vertical displacement occurs in the two impression transfer copings evaluated in this study.

Keywords: *Accuracy, closed tray, implant impression, plastic coping, three dimensional.*

Introduction

The accuracy of a definitive cast for implant restorations depends on several factors, including the impression technique [1-3], type of impression material [2,3], die material [4], and pouring techniques [1]. For example, an inaccurate impression might lead to prosthesis misfit, which may then result in biological and mechanical complications. Although an absolutely passive prosthesis fit is not achievable [5].

For restoration of fully and partially edentulous patients, with implant supported dentures an important factor for success is the passive fit between the superstructure and the abutments. Reproducing the intraoral relationship of implants through impression procedures is the first step in achieving an accurate, passively fitting prosthesis. The critical aspect is to record the 3-dimensional orientation of the implant as it occurs intraorally, rather than reproducing fine surface detail. The accuracy of impression procedure lies in reproducing the intraoral relationship of the fixtures so that same could be transferred to the cast so that a passive framework could be fabricated [6-10].

Currently, each implant system has its own set of machined impression copings that connect to the implant and facilitate the replication of the implant position to a stone cast. An impression coping is the component of a dental implant system that is used to provide a spatial relationship of an endosteal dental implant to the alveolar ridge and adjacent dentition or other structures. Impression copings can be retained in the impression; this is termed an impression pick-up procedure. Also, the copings may require a transfer from intraoral usage to the impression after attaching the analog or replicas; this is termed an impression transfer procedure. An implant analog is a replica of a portion of an implant abutment made of brass, aluminum, steel, or plastic [11].

For implant impression making, transfer techniques have a decisive influence on the fabrication of accurate working casts. Both direct (open-tray) and indirect (close-tray) techniques for transferring implant position to the working cast are commonly used in dental practice [12]. The indirect technique may be less difficult clinically; however it may been shown to have greater instability in transferring the implant position [13]. While some authors reported better results with the direct technique [14-18]. Humphries and colleagues found that the indirect technique was more accurate, required less working time, was easier for the operator [19], and also more comfortable for the patient [15,17].

Patients and methods

Acrylic resin model representing a completely edentulous mandibular ridge was used. Through the guide template a twist drill attached to the dental milling machine was used to drill vertical four holes (in the canines and first molars). Four dental implants (SuperLine&Implantium, Dentium, Seoul, South Koria) 3.4 mm diameter, and 10 mm length were secured into its holes and were fixed using autopolymerizing acrylic resin. 2 mm thickness autopolymerizing silicone soft liner material covering the ridge to simulate the oral mucosa.

Five circular depressions (6 mm width and 3 mm depth) were made in the land area (one at midline, two at the molar area at both sides and two posterior to the retromolar area) of the acrylic resin model (Fig. 1) to help orient and verify the complete seating of the custom tray and standardize it's positioning each time during the impression making procedure [2]. Closed tray for impression was made from autopolymerizing acrylic resin, perforations were made in the custom tray to provide mechanical retention for the impression material and to allow any excess impression material to escape. Ten impressions were made from two groups: Group I: impression with metal transfer copings. Group II: impression with plastic transfer copings.

In group I, each metal transfer coping was secured and tightened with hex driver to each implant fixture, the custom tray was coated with adhesive (Vinylpoly siloxane tray Adhesive, 3M ESPE DG) using the brush and allowed to dry for15 minutes before impression making, using vinylpoly siloxane impression material (Express™ Firmer Set, 3M ESPE, Imprint™ II Garant™ Quick step, Light body, 3M ESPE) one-step dual phase impression technique (putty-wash technique) [20,21]. Equal volumes of putty base and catalyst were mixed with fingertips until a uniform color is achieved (20 seconds) and loaded inside the custom tray and dental dispensing gun was used to mix light body that was injected around each impression coping and at the reference point in the center of the cross-shaped grooves, the loaded tray was positioned in place once on the acrylic resin model.

A1.25 kg was seated above the acrylic tray (Fig. 2) to standardized the pressure during setting time and allow the excess material to escape.[2] After removal of the impression, the four impression copings were unscrewed from the four implant fixtures, and threaded onto the corresponding implant replica and immediately replaced into its corresponding location in the impression by firmly pushing it into place to full depth and slightly rotating it clockwise to feel for the antirotational resistance.

Using the dental flask a box for pouring the impression with dental stone was made with condensation silicone. The matrix was used for all of the impressions, allowing standardization of the format of the casts and of the amount of dental stone employed for the pouring [2]. In group II, four positioning dual abutments were secured with hex driver to each of the implant fixtures, each plastic impression cap was pushed onto the abutment until it clicked into place. The same procedures of impression making as in group I, after removal of the impression the four plastic snap-on impression copings in it, the four positioning dual abutments were unscrewed from the four implant fixtures and threaded onto the corresponding implant replica and immediately replaced into its corresponding location of each plastic impression coping by pushing until it clicked into place to full depth. The same procedures of pouring the impression as in group I.

Measurement

A standard measurescope capable of measuring of three dimensional positions of the implants were done, two dimensional (X and Y axes) with measuring capabilities of 0.001 mm. Six measurements was recorded center-to-center distances between the four metal transfer copings on its top surface and were referred to as A-B, A-C, A-D, B-C, B-D, C-D (Fig. 3). The main lens of the measurescope was replaced by sensitive dial gauge to measure the third dimension (Z-axis). This dial gauge has a scale of 0.001 mm per division and it was held into a central position using implant abutment. Acquisition of data was done directly by computer connected to the measurescope. The reference point (R) was recorded by adjusting the vertical metal arm attached to the dial gauge at the center depression of the cross-shaped on the acrylic resin model (Zero point). The travelling table was moved in X and Y directions till the dial gauge vertical arm reached abutment of implant A and the vertical coordinate (Z) was recorded from the scale of the dial gauge (Fig. 4).

Statistical analyses

The SPSS statistical package for social science version 22 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Shapiro-Wilk test was used to test the normality of the recoded values. The data was parametric and normally distributed. One way analysis of variance (ANOVA) was applied to test possible differences in measured distances between different distances in horizontal plane (Distance A-B, Distance A-C, Distance A-D, Distance B-C, Distance B-D and Distance C-D) and vertical plane (Distance R-A, Distance R-B, Distance R-C, and Distance R-D). Subsequently, *post hoc* tests (Turkey) were used for pairwise comparisons of results. P is significant if < 0.05 at confidence interval 95%.

Results

Comparison of changes between different distances in horizontal plane:

1- Group I (metal copings):

Comparison of changes between different distances in horizontal plane (Distance A–B, Distance A–C, Distance A–D, Distance B–C, Distance B–D and Distance C–D) for group I (metal copings) are presented in Table 1. There was no significant difference between different distances in horizontal plane for group I (One Way ANOVA, p= .23).

2- Group II (plastic copings):

Comparison of changes between different distances in horizontal plane (Distance A–B, Distance A–C, Distance A–D, Distance B–C, Distance B–D and Distance C–D) for group II (plastic copings) are presented in table (2). There was a significant difference between different distances in horizontal plane for group II (One Way ANOVA, p= .036). The A-C distance recorded the highest change and the A-D distance recorded the lowest change. Multiple comparisons between each 2 distances using the Tukey post hoc test are presented in Table 2. Similar letters indicating a significant differences between distances. There was a significant differences between A-B distance and A-C distance and between A-C distance and A-D distance (Tukey post hoc test, p<.05).

Comparison of changes between different distances in vertical plane:

1- Group I (metal copings):
Comparison of changes between different distances in vertical plane (Distance R–A, Distance R–B, Distance R–C, and Distance R–D) for group I (metal copings) are presented in Table 3. There was no significant difference between different distances in vertical plane for group I (One Way ANOVA, p= .911).

2- Group II (plastic copings):
Comparison of changes between different distances in vertical plane (Distance R–A, Distance R–B, Distance R–C, and Distance R–D) for group II (plastic copings) are presented in Table 4. There was no significant difference between different distances in vertical plane for group II (One Way ANOVA, p= .65).

Discussion

A successful implant restoration can be achieved only when a passively fitting prosthesis is fabricated. The impression must record the soft tissue supporting areas simultaneously with accurate positioning of implant components. Reproducing the intraoral relationship of implants through impression procedures is the first step in achieving an accurate passively fitting prosthesis [22].

The results of this study revealed insignificant increase in the different distances in horizontal plane for group I (non-splinted metal coping) compared to those in the acrylic resin model (control group). This result may be due to the minor movement of the non-splinted metal coping during impression procedures. This result is in agreement with Stimmelmayr et al. [23] who evaluate the accuracy of three different impression techniques (transfer impression posts with plastic caps, pick-up and splinted pick-up). They reported more accurate results of the splinted pick-up technique than transfer technique.

On the other hand, a significant increase in the different distances in horizontal plane for group II (plastic coping) was observed. This may be attributed to the loss of tactile sensation in the snap and improperly assumes that the transfer coping is properly seated. Instead, the decreased accuracy with the closed tray/direct technique using the plastic impression cap may prone to permanent distortion or deformation with loading. This is in agreement with Walker et al. [24] who reported less accurate impressions for the closed tray/direct impression technique with plastic impression caps. Deformation could occur during impression removal or even be associated with additive distortion, if the impression cap is inserted and removed multiple times prior to final impression making.

It was observed that, the A-C distance recorded the highest change and the A-D distance recorded the lowest change. This means that no impression transfer technique proved to be 100% accurate. This is in agreement with Waskewicz et al. [25] and Assuncao et al. [8] who reported that in a good impression, there is a possibility of finding a discrepancy of 50 μm in any axis and there is impossibility of 100% passive fit.

The results of this study revealed insignificant difference between the two groups (metal and plastic copings) either in vertical or horizontal plane. This result is in agreement with Fernandez et al. [26] who compare the accuracy between casts fabricated using plastic impression copings and casts made using metal impression transfer copings with an implant level technique. They found no difference between metal and plastic copings for the Nobel Replace system. Also this result is in agreement with Teo et al. [27] who compare the three-dimensional accuracy of plastic indirect abutment-level impression copings and metallic direct implant-level impression copings from three implant systems (Nobel Biocare, Biomet 3i, and Straumann) at three interimplant buccolingual angulations (0, 8, and 15 degrees). They found that the accuracy of the plastic indirect abutment-level impression copings was comparable to that of the metallic direct implant-level impression copings for the Nobel Biocare Brånemark implant system at 0 and 8 degrees of interimplant angulation and for the Biomet 3i and Straumann implant systems at 0, 8, and 15 degrees of interimplant angulation.

It was observed that, the mean changes in distances for vertical plane was significant greater than horizontal plane in each group. This may be attributed to the displacement of each impression coping on the mating surface of each implant within the range of machining tolerance. This result is in agreement with Ma et al. [28] who assessed the fit of Nobel Biocare components and found that the average vertical discrepancy between abutments and prosthetic cylinders was 23.1 to 33.1 um. Also this result is in agreement with Rubenstein and Ma [29], Kim et al [12] and Lee et al. [30] who believed that a significant amount of the discrepancy might have originated from the machining tolerance.

Conclusion

It is possible to conclude that: 1- Regarding the displacement in horizontal plane, the impression transfer metal coping can be considered better than the impression transfer plastic coping. 2- Considerable vertical displacement occur in the two impression transfer copings evaluated in this study.

Table 1: *Comparison of changes between different distances in horizontal plane for group I (metal coping).*

Distance in horizontal plane	Mean ± standard deviation
Distance A-B	.0944000±.07980420
Distance A-C	.2048000±.13838497
Distance A-D	.1290000±.08818037
Distance B-C	.1040000±.07893035
Distance B-D	.1349000±.12816348
Distance C-D	.1213000±.09424089
One Way ANOVA (p value)	**.23 (NS)**

NS; p value is not significant at .05% level of significance.

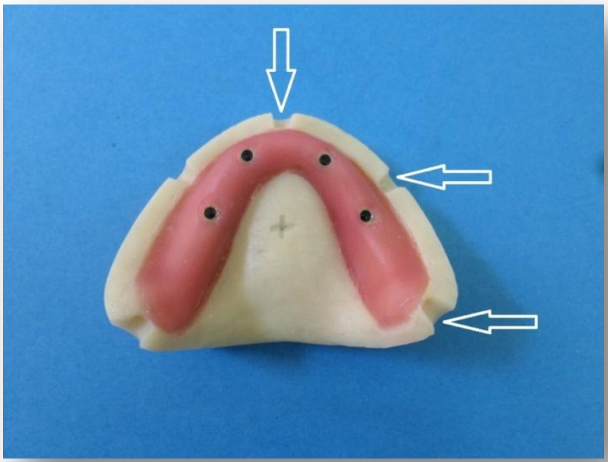

Figure 1: Five circular depressions in the land area of the acrylic resin model.

Figure 2: A1.25 kg seated above the acrylic tray.

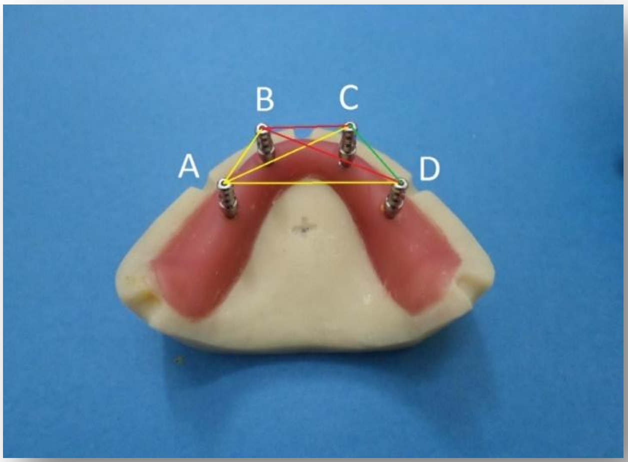

Figure 3: Six measurements of the horizontal coordinates were made and repeated on the acrylic resin model and the 20 fabricated stone casts (yellow; AB, AC and AD)(Red; BC and BD)(Green; CD).

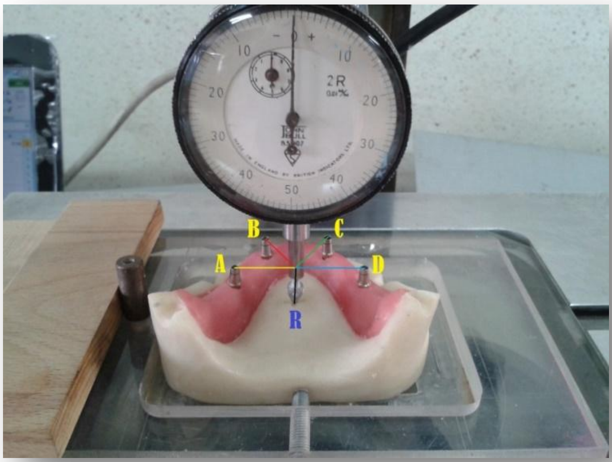

Figure 4: Measurements of the vertical coordinates of the abutment of implant (A, B, C and D) in relation to the reference point on the acrylic resin model (R).

Table 2: *Comparison of changes between different distances in horizontal plane for group II (plastic coping).*

Distance	Mean ± standard deviation	Tukey post hoc test
Distance A-B	.0781000±.04299212	A
Distance A-C	.1672000±.04931711	A B
Distance A-D	.0745000±.09407710	B
Distance B-C	.1428000±.07659968	
Distance B-D	.0943000±.05722286	
Distance C-D	.1260000±.10207840	
One Way ANOVA (p value)	**.036***	

*; p value is significant at .05% level of significance. Similar letters indicating a significant differences between distances (Tukey post hoc test, p<.05).

Table 3: Comparison of changes between different distances in vertical plane for group I (metal coping).

Distance in vertical plane	Mean ± standard deviation
Distance R-A	.1600000±.19629909
Distance R-B	.2120000±.14211107
Distance R-C	.1900000±.15376750
Distance R-D	.2020000±.17843766
One Way ANOVA (p value)	**.911 (NS)**

NS; p value is not significant at .05% level of significance.

Table 4: Comparison of changes between different distances in vertical plane for group II (plastic coping).

Distance in vertical plane	Mean ± standard deviation
Distance R-A	.1780000±.13862820
Distance R-B	.2610000±.25795995
Distance R-C	.2460000±.22292002
Distance R-D	.1780000±.08941787
One Way ANOVA (p value)	**.65 (NS)**

NS; p value is not significant at .05% level of significance.

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