Effect of impression technique and material on accuracy of implant impressions

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Abstract

Dental implant treatment becomes one of the most predictable and successful dental rehabilitation therapies. After successful osseointegration, impression making is one of the most important and critical steps in implant prosthesis fabrication for long term successful use. An accurate impression and stone casts are extremely important because inaccuracy in any of these can lead to mechanical and /or biological complications which ultimately result in failure of implant restoration.

An in vitro study was carried out to evaluate linear dimensional accuracy of implant impressions by using different silicone impression materials and different impression techniques.

Four implants (Arrow Mytis Implant System, Brainbase Co. Ltd., Tokyo, Japan) were placed parallel to each other in the edentulous mandible model using the surgical guide at canines and first molar areas. Fixture-level impressions were made by using addition silicone (Perfit, Huge, Rizhao, China) or condensation silicone (Silect Set, Muller-Omicron GmbH&Co.KG, Germany) with putty-light body wash one-step procedure, with closed tray or open tray technique and poured with dental stone (Silky Rock, Type IV stone, U.S.A). Three hours after removal of impression from the stone cast, four measurements (AB, BC, CD, AD) were taken between implants by using digital slide caliper (Hummer, Thailand) with accuracy of +0.03mm. Data was analyzed by using one-way ANOVA.

There was no statistically significant difference in deviation of linear dimension between the impression materials and techniques. It is concluded that both addition and condensation silicones may ensure acceptable accuracy with either closed tray or open tray technique for implant impressions.

Keywords: Accuracy, addition silicone, condensation silicone, impression materials, implant

Introduction

Nowadays, dental implant treatment becomes one of the most predictable and successful dental rehabilitation therapies. After successful osseointegration, one of the most important and critical steps in implant prosthesis fabrication for long term success of dental implant is impression making. The accuracy of the impression affects the accuracy of definitive cast on which the final prosthetic restoration is fabricated. The inaccurate impression may

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result in misfit prosthesis leading to mechanical complications such as screw loosening, screw fracture, occlusal inaccuracy [1,2]. For a precise fit of the final prosthesis, the accurate definitive cast is imperative which further depends on the mechanical and physical properties of the impression material, the impression technique, the impression tray used, and depth and angulation of implant placement as well as the accuracy of the die materials [3].

Generally, impressions for implant restorations can be made in two ways: abutment-level impression and fixture-level impression. Impression can be taken with open tray or closed tray, and may use metal or plastic impression copings. Two different impression techniques are traditionally used in fixturet-level impression: pick up (open tray) technique and transfer (closed tray) technique. Transfer technique is reported to be required less operation time and suitable for short interarch distance whereas pick-up technique is more accurate [4, 5].

Polyether and addition silicone were recommended as the impression material of choice for the implant impression [2, 6]. Although polyether has been suggested as the material choice, addition silicone reduces the permanent deformation of the impression and have more favorable rigidity to allow easy the removal of the set impression [7, 8]. It has been reported that impressions with putty and light-body combination of polyvinyl siloxane are more precise than medium-body polyether when implants are located deeply under mucosa [9].

The condensation silicone has high polymerization shrinkage because of the release of by-product, whereas addition silicone does not release by-product but hydrogen gas released from that can result in voids in the gypsum cast [10]. Nevertheless, a wide range of condensation silicones are used for implant impression with claims of equally good results as addition silicones [11].

The purpose of this vitro study was to evaluate linear dimensional accuracy of implant impressions by using different silicone impression materials and different impression techniques.

Materials and methods

A reference acrylic resin model simulating an edentulous mandibular ridge was fabricated with 4 internal connection implants (Arrow Mytis Implant System, Brainbase Co. Ltd., Tokyo, Japan) in the canine and first molar region on both sides. Four implants were placed nearly parallel using the surgical guide to simulate a clinical situation. Cover screws were tightened on four implants to measure the linear dimension between the implants and were noted sequentially A to D (from right to left) (Figure 1A).

Fixture-level impressions were made by using addition silicone (Perfit, Huge, Rizhao, China) or condensation silicone (Silect Set, Muller-Omicron GmbH&Co.KG, Germany) with putty-light body wash one-step procedure, with pick up or transfer technique. Metal tray with rim lock was used in all the impression. Impression copings and analog used in the study were shown in figure 1B. In transfer technique, transfer copings were connected to the implants and impression was taken with closed tray technique. After the removal of impressions, the copings were then removed from the implant, attached to the implant analogs and reinserted in the impression. In pick up technique, the impression coping was incorporated in the impression and retaining screw was released before the set impression was removed from the mouth.

Four groups were divided based on the impression techniques and the impression materials: group 1 - pick up technique, addition silicone, group 2 -

transfer technique, addition silicone, group 3 - pick up technique, condensation silicone, group 4 - transfer technique, condensation silicone and five impressions were made for each group.

Figure 1(A) Reference acrylic resin model with 4 implants being noted A to D (from right to left) (B) Impression copings and fixture analog (C) Inner surface of set impression with gum work poured around the bases of fixture analogs (D) Stone model with fixture analogs

The impression material was allowed to polymerize for 2 minutes longer than the setting time recommended by the manufacturer. After removal of the impressions from the model, implant analogs were connected to the impression copings and separating medium was applied. And then, the light body of silicone was injected as a gum model (Figure 1C).

One hour after taking the impression, the impressions were poured using Type IV dental stone (Silky Rock, Type IV stone, U.S.A) and mixed according to the manufacturer's recommendation in a vacuum mixer and poured the casts. The casts were separated from the impression after 20 minutes. Cover screw were tightened on the lab analogs (Figure 1D). All casts were stored

at room temperature for 3 hours before measurements were made.

Measurements

To examine the linear dimensional accuracy of implant impression, fixture analogs in the cast were named A, B, C and D from right to left. Measurements were taken between center points of cover screws between two fixture analogs: four measurements (AB, BC, CD, AD) were taken on the reference model and twenty definitive casts by using digital slide caliper (Hummer, Thailand) with the accuracy of +0.03mm. All the measurements were recorded three times by the same operator, and the mean value was calculated.

Statistical Analysis

Deviation of linear dimension was calculated from the obtained measurements of stone cast and reference models for each measurement. One way analysis of variance was used to analyze the differences among the groups. P value <0.05 was considered as statistical significance.

Results

Figure 2,3,4 and 5 depict the mean deviations and standard deviations of linear dimension in AB, BC, CD and AD measurement in 20 casts compared from control values on the reference model for 4 studied groups. The mean deviations ranged from 0.04 to 0.31mm and pick up technique with additional silicone displayed the least deviations in AB, CD and AD but it also showed the most distortions in BC.

The difference between the two impression techniques was not statistically significant (P>0.05). Furthermore, there was also no statistically significant difference between condensation and addition silicone (P>0.05).

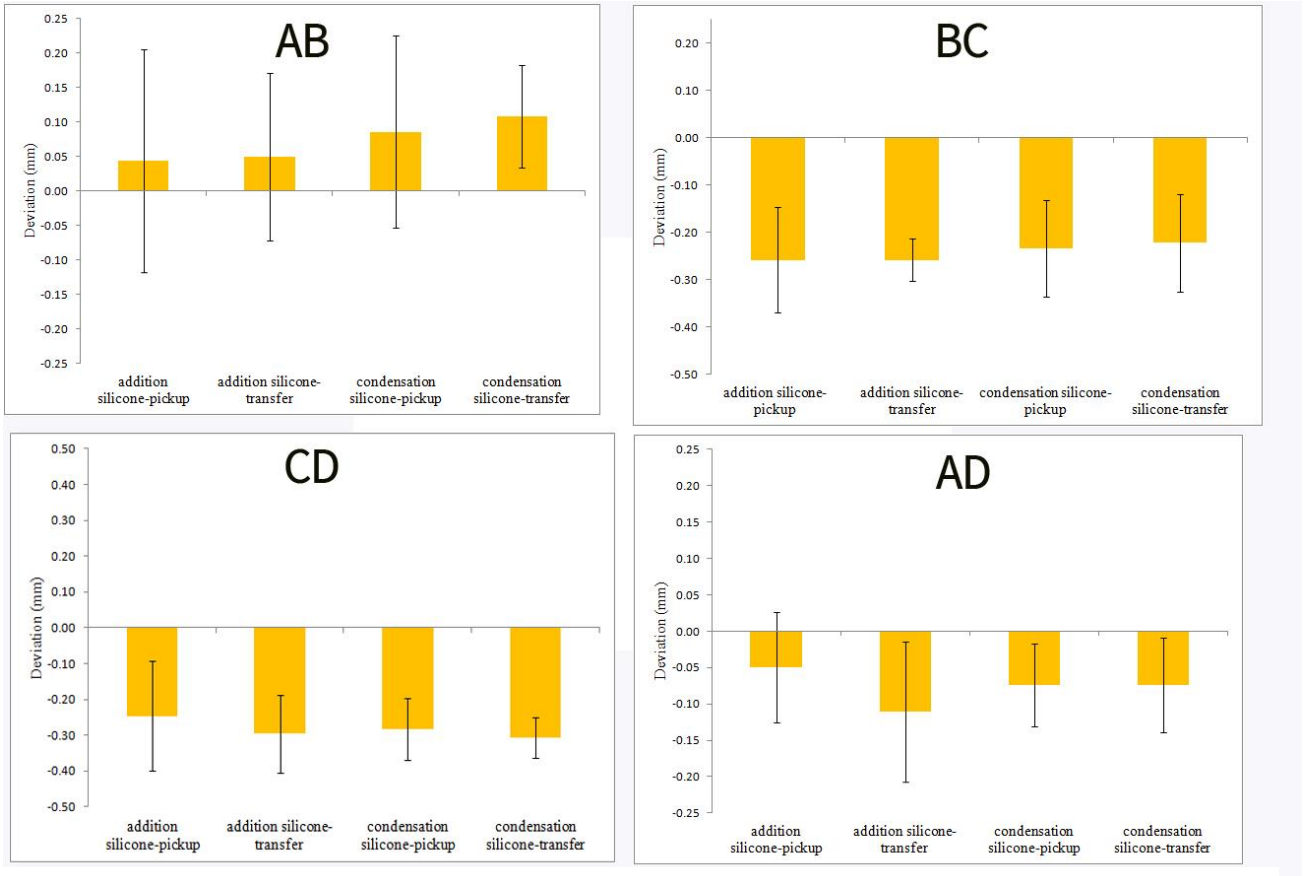

Figure 2: Mean deviation of linear dimension at AB, BC, CD and AD

Discussion

In implant prosthodontics, the successful result can be obtained only when the passive fit can be achieved [12][13][14]. According to Cox and Zarb, the lack of passive fit between the prosthetic components and the implants lead to place additional stresses on the implants and strain to the components resulting in these components fracture itself, implant fracture or loss of peri-implant bone [15].

In the present study, open tray and closed tray impression techniques were compared using addition-type and condensation-type silicone impression materials. According to the results, both impression techniques are comparable in accuracy. In a literature review, Lee et al concluded that the pick up or transfer technique can produce useful results for situations in which 3 or fewer implants, whereas 4 or more implants, most studies showed higher accuracy with the pick up technique [1]. Daoudi et al. reported that the transfer coping could not be seated to the original position and pointed out this phenomenon as the primary source of error in the transfer technique. The possibility of this error is reported to be further increased when impression of multiple implants are made [16]. The pick up technique removes the concerns for replacing the coping back in to its original position but it is also reported to be vulnerable to some rotation movements of the impression coping when securing the implant analog [5][6]. In the present study, 4 implants were placed on the dummy model and the experiment was conducted. It should be noted that all implants were placed parallel to each other. The results indicated comparable accuracy of impression with transfer copings to pick up copings. It may be due to the fact that the impression was not distorted when removing from the model and also that transfer copings were accurately seated inside the impression. The shape of transfer copings of Arrow implant system allows precise and stable seating of transfer coping inside the set silicone impression.

One of the sources of error is unstable impression copings inside the impression material. When the fluid impression material is not injected around the impression coping properly, the resultant impression cannot hold the coping securely and results in loose sitting of coping inside the material. Such movement of impression copings inside the impression material during clinical step and/or laboratory procedures may also cause inaccuracy in transferring the three-dimensional spatial orientation of implants from the mouth to the definitive cast. Rashidan et al (2009) emphasized that shape of impression coping influences more on impression inaccuracy than impression technique because less retentive shape impression copings results in less inaccuracy compared with more retentive one regardless of impression techniques [17]. In this aspect, both transfer and pick-up copings used in the present study were properly shaped so that they are stable inside the silicone impression.

Many authors have reported more accurate multiple implant impression with the splinted technique than with the non-splinted technique, especially for edentulous arch receiving four or more implant and in greater angulation [1][2][18][19]. Some possible problems may be occurred related to the splint techniques, such as distortion of the splint materials, polymerization shrinkage of the resin and the section of the splint materials. Therefore, splinting the coping rigidly prior to the impression procedure was not used in this study because this study focused on the effects on the deviation of the impression copings and materials.

The clinical situations which indicate the use of the pick up impression techniques are when the implant is located between two anterior teeth or when the implants are not sufficiently parallel to allow an impression to be withdrawn from multiple impression copings. But, it is also more time consuming and limits in reduced interocclusal space. Conversely, the transfer technique can be used when the implants are sufficiently parallel to each other or in situations with limited inter-arch distance and insufficient space for use of pick-up copings.

The result obtained from this study indicated that some distortion of impression would occur although there was no significant difference in the dimensional accuracy of cast in terms of linear measurements between the pick up and transfer impression technique with any type of silicone and the result corresponds to most available literature. Consequently, the restoration may require corrective procedures despite using an open-tray or close-tray impression technique.

Various studies have compared the accuracy of polyether and PVS and reported that that the accuracy of this materials did not differ [3][20]. Although polyether has been suggested as the material choice for the implant impression, its use for the impression of partially edentulous arch may increase difficulty to remove from the undercut area. A more elastic impression material such as PVS may be more suitable to reduce the permanent deformation of impression material between the copings and the impression when the impression is removed from the implants [12]. Bilge et al reported that the stiffness of impression material is not essential for an accurate impression of multiple implants because medium body PVS could produce casts that are more accurate than those produced with polyether in that study[21]. Lee et al also showed that PVS is more accurate than polyether when the implant was placed subgingivally [22].

In the impression of the conventional fixed prosthesis, it was reported that the dimensional accuracy of addition silicone (Aquasil) was better than condensation silicone (Zetaplus) [23]. For the implant impression, Ali Jameel reported that addition silicone was more accurate in contrast to condensation silicone [8]. These findings agree with other studies reporting that condensation silicone has less dimensional stability resulting from shrinkage due to release of the ethyl alcohol byproduct [8,10,18]. In Wessam et al study, no significant difference was reported between putty/light and medium consistency polysiloxane condensation silicone to accurate reproduction of implant position. It was claimed that a monophase materials would not flow around the structures as compared to putty/light body materials. But, significantly larger dimensions in two groups were observed when compared with the control model [24]. As a result from the present study, there was no significant difference in impression accuracy between addition and condensation silicone in all groups. although the polymerization shrinkage seemed to occur in this study, the values were considered to be within the clinically acceptable accuracy. Addition silicone has advantage of easier manipulation.

Impression technique may also influence the accuracy of the implant impressions. According to Wenz et al, the 2 step PVS impression was significantly less accurate than 1 step putty-light body PVS impression, monophase PVS impression and the medium body polyether monophase impression [25]. When two impression techniques (putty/light polysiloxane rubber-based impression material and medium body polysiloxane rubber-based impression material) (Speedex; Coltene, Altsta¨tten, Switzerland) were compared, significantly

larger dimensions were observed when compared with the control model [26].

Nevertheless, the dimensional changes were observed in all groups when compared with the reference model in the present study. Apart from influences of impression materials, techniques and impression coping types, possible expansion/contraction of stone material should also be considered that may also be the additional problem on the accuracy of the definitive cast.

This study has some limitations: study was conducted at room temperature rather than mouth temperature. Therefore, to validate this result, further studies with a temperature similar to that of the oral cavity are needed. Since new digital technology and enhanced biomaterials are simplifying the restoration of implants with CAD/CAM facilities and making the chair side dental treatment quicker for patients, future direction should be comparison of conventional versus digital workflow in terms of accuracy, efficiency and patient comfort.

Conclusion

Within the limitations of this study, both addition and condensation silicones may ensure acceptable accuracy with either transfer or pick up technique for implant impressions. However, it is impossible to produce 100% accurate replica of the master model, despite the low deviations obtained in the study.

Conflict of interest statement

Authors had no conflict of interest with the implant system and impression materials used in this study.

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