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Accuracy of the implant impression obtained from different impression materials and techniques: review

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Abstract

With the predictable integration of implants, the emphasis is shifted towards precise prosthesis. 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 three dimensional orientation of the implant as it is present intraorally, other than reproducing fine surface detail for successful implant prosthodontic treatment. The development of impression techniques to accurately record implant position has become more complicated and challenging. During the prosthetic phase of implant therapy there are numerous options available to the implantologist in relation to different impression techniques and materials available for impression making. It is critical to ensure that implant – prosthesis interface have passive fit and original position of the implant maintained in the master cast. There is no evidence supporting that one impression technique or material is better than the other. In the present article the various parameters affecting the accuracy of implant impression along with impression material and technique pertaining to different clinical situations is reviewed.

Key words: *dental implants, impression techniques, snap fit technique, open tray technique, closed tray technique.*

Introduction

Osseointegrated dental implants have been proven successful in the treatment of edentulism (1). Mainly, osseointegrated implants were used for rehabilitation of edentulous patients with the principle objective of replacing conventional complete dentures with an implant-supported prosthesis. Other applications of implants in dentistry include partially edentulous, single-tooth, and implant overdenture treatments (2). In implant prosthodontics, a successful result can be achieved only when passively fitting prostheses are fabricated (3). 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 is present intraorally, other than reproducing fine surface detail for successful implant prosthodontics treatment (4-6).

Although there is some evidence that prosthesis misfit may not affect osseointegration, there is evidence that prosthesis misfit is likely to increase the incidence of mechanical component loosening or fracture. The causes of component failure and loosening are multifactorial, but it must be assumed that prosthesis misfit plays an important role in complications such as occlusal and abutment screw loosening and fracture in implant restorations (7-10). Because of these, prosthesis misfit is to be minimized.

An electronic search was performed from MEDLINE databases with the key words accuracy of implant impression techniques. To be included, the study had to investigate the accuracy of implant impressions techniques and materials and be published in an English peer-reviewed journal. In addition, hand search of related articles were performed to enrich the results for the time period from January 1983 to June 2009.

At present, various implant impression techniques, such as splint, pickup, and transfer techniques and different impression materials, like polyether, vinyl polysiloxane (VPS), and polysulfide have been introduced and investigated for accuracy. Other factor related to the accuracy of the implant impression, including the angulation or depth of implants has also been studied. However, the results are not always consistent, and various studies reported greater accuracy with different impression techniques as well as impression materials. The purposes of the present review are to investigate the:

- 1) Accuracy of reported implant impression techniques.
- 2) Accuracy of various implant impression materials.
- 3) Factors affecting the implant impression accuracy.

One of the most important factors for the success of implant prosthesis is the accuracy of the impression procedure, in order to obtain the original position of the implants during the processing of the master cast and to allow the passivity of the framework casting to

its supporting abutments without interference between the prosthesis-implant connections. The development of impression techniques to accurately record implant position has become more complicated and challenging. Several impression techniques have been suggested to obtain a master cast that will ensure the passive fit of prosthesis on implants (11).

Impression Techniques

Splint Technique Versus Nonsplint Technique

The splint technique for an implant impression was introduced along with the development of a metal-acrylic resin implant fixed complete denture for an edentulous jaw. The underlying principle was to connect all the impression copings together using a rigid material to prevent individual coping movement during the impression making procedure. From the studies examining implant impression accuracy, splinting has been an important subject of investigation.

Among the impression making methods presented in the literature, the splinted technique has gained popularity and has proven to be the most accurate (12,13). Even though there was no consistent result for higher accuracy with any one technique as opposed to the other, splint or nonsplint, more number of studies has reported increased accurate implant impressions with the splint technique than with the nonsplint technique. Some authors suggested possible problems with the splint technique, such as distortion of the splint materials (14) and fracture of the connection between the splint material and the impression copings (15). Kim et al. (16) investigated the accuracy of the implant impression over multiple laboratory procedures and found that the nonsplint technique was more accurate during the impression-making procedure, while the splint technique was more accurate during the cast fabrication procedure (Table 1).

Acrylic resin is the material used quite often for splinting, thus, minimizing the shrinkage of the acrylic resin is the most important factor to ensure an accurate impression using the splint technique. Some authors sectioned the splint material connection, leaving a thin space between, then rejoining with a minimal amount of the same material to minimize the shrinkage or they connected all of the impression copings with splint material, and then waited for complete polymerization of the material (17-20).

The splinting technique using light cured acrylic resin was significantly less accurate than by using autopolymerizing resin or by impression plaster. This may be caused by the incomplete polymerization of the light cured acrylic resin; another reason may be that the shrinkage during polymerization of the light cured acrylic resin creates stresses at the impression coping / acrylic resin interface. There is also significant importance to the intensity and direction of the light source that might have

Author (Year)	Implant number	Splint material	Splint method	Impression material	Impression accuracy
Barrett et al. (4) (1993)	6	DF+AAR	Splint 10 min before impression	VPS	No difference
Assif et al. (12) (1992)	5	AAR	Polymerize on individual copings, then join 15 min before impression	PE	Splint
Assif et al. (13) (1996)	5	AAR	Splint Splint copings to custom tray	PE	Splint
Inturregui et al. (17) (1993)	2	Impression plaster AAR	Splint and wait for 10 minutes Splint, section, then rejoin 15 min before impression	PE	Non splint
Hsu et al. (18) (1993)	4	DF+AAR Stainless steel wire+AAR AAR	Splint 20 min before impression Splint 20 min before impression Polymerize on individual copings, then join 20 min before impression	PE	No difference
Naconecy et al. (19) (2004)	5	Steel pin+AAR	Splint 30 min before impression	PE	Splint
Del' Acqua et al. (20) (2008)	4	AAR	Splint, section, then rejoin before Impression	PE	No difference
Assuncao et al. (29) (2004)	4	AAR	Splint	PE, VPS, polysulfide, condensation silicone	Splint
Herbst et al. (35) (2000)	5	DF+AAR	Splint 20 min before impression	VPS	No difference
Cabral et al. (38) (2007)	2	DF+AAR	Splint 3 min before impression Splint 17 min, section, then rejoin before impression	VPS	Splint

AAR: autopolymerizing acrylic resin; DF: dental floss

VPS: vinyl polysiloxane; PE: polyether

Table 1. Studies comparing accuracy of splint and nonsplint impression techniques

a negative influence on the adaptation of the light cured acrylic resin to the coping. Impression plaster sets rapidly, is quite accurate and rigid, and does not bend or distort, it is also easy to manipulate, less expensive. The exothermic reaction is negligible (21). It was interesting that more studies advocating the splint

technique were found within recent literature. Five out of 7 studies recommending the splint technique were published after 2003, as opposed to 2 older studies which appeared before 1996. Modifications in splinting techniques and its manipulation may result in minimizing the distortion.

Transfer Technique Versus Pick-Up Technique

Traditionally, there are 2 different implant impression techniques for transferring the impression copings from the implant to the impression. The transfer technique uses tapered copings and a closed tray to make an impression. The copings are connected to the implants, and an impression is made and removed from the mouth, leaving the copings intraorally. Subsequently the copings are removed and connected to the implant analogs, and then the coping-analog assemblies are inserted in the impression before pouring the definitive cast. The clinical situations which indicate the use of the closed tray technique are when the patient has limited interarch space, tendency to gag, or if it is too difficult to access an implant in the posterior region of the mouth (22).

Conversely, the pick-up impression uses square copings and an open tray (a tray with an opening), allowing the coronal ends of the impression coping screw to be exposed. Before separating the implants, the copings screws are unscrewed to be removed along with the impression. The implant analogs in the impression are connected to the copings to fabricate the definitive cast. Disadvantages of this technique is that there may be some rotational movement of the impression coping when securing the implant analog, and blind attachment of the implant analog to the impression coping may result in a misfit of components (23). Fourteen studies have compared the accuracy of pick-up and transfer impression techniques, twelve studies reported that the accuracy did not differ and 2 studies showed more accurate impressions with the transfer technique. However, the results of 1 of the 2 studies were questionable because the experimental design was not clinically relevant and favored the transfer (24) technique and it was the only study that advocated the transfer technique when 3 or fewer implants were placed (25).

Daoudi et al. (26) compared the closed tray technique at the implant level with the open tray technique at the abutment level for single tooth implants and found the open tray technique to be superior and more predictable. The closed tray technique had discrepancies in axial rotation and inclination of the analogs. Several authors have reported the superiority of the open tray technique. Carr (27) compared the open and closed tray techniques with a 5 implant mandibular cast where the interabutment divergence angles were all less than 15 degrees. The open tray technique was found to be superior as it provided the most accurate working cast. Carr (27) indicated that the inaccuracy of the closed tray technique may arise from nonparallel implants and the apparent deformation of a stiff impression material such as polyether. In a subsequent paper evaluating a 2 implant situation, 1 parallel to the long axis of the teeth and the other with a 15 degree lingual inclination, Carr (27) reported that both techniques provided comparable results.

Daoudi et al. (26) investigated repositioning of the copings after making the transfer impression by 3 different groups of people: senior dentists, postgraduate dental students, and dental technicians. The copings never returned to the original position and this was believed to be the primary source of error in the transfer impression technique. This error could be multiplied when the impression is made in situations of multiple implant placements. It was found that for situations in which there were 4 or more implants, more studies showed more accurate impressions with the pick-up technique than the transfer technique.

Some implant manufacturers have developed a snap-fit (press fit) plastic impression coping. This technique is not a pick-up impression because it does not require an open tray, but instead uses a closed tray. It is not a transfer impression, either, because the plastic impression copings are picked up in the impression. The press-fit impression coping is easier to manipulate, time saving, and more comfortable for both the clinician and patient because the coping is connected to the implant by pressing instead of screwing. The press-fit coping design allows removal of the coping with the impression and has the advantage of both the open- and closed-tray implant impression techniques. Thus, the press-fit impression coping helps to overcome movement of impression copings inside the impression material. The snap-fit technique may be a reliable impression making technique (28) but regarding accuracy of this technique none of the study is available for investigation.

Impression Materials

Various impression materials were tested; polyether and VPS were used most frequently. There were 11 studies comparing the accuracy of polyether and VPS, and 10 studies reported that the accuracy did not differ (4,25,29). Lee et al. (30) reported that putty and light-body combination VPS impression material was more accurate than medium-body polyether impression material, when the implant was placed deep subgingivally. Wenz et al. (31) investigated different mixing methods of the impression materials. According to the study, the 2-step VPS method involves making the first impression using putty only, to create space inside of the impression. Subsequently, the impression is filled with light-body impression material, and then the second impression is made. The 1-step method uses both putty and light-body VPS simultaneously. Results indicated that the 2-step VPS impression was significantly less accurate than the 1-step putty and light-body VPS combination impression, the medium-body VPS monophasic impression, and the medium-body polyether monophasic impression. Although polyether has been suggested as the material of choice for implant impression procedures, the use of a more elastic impression material, for example a vinyl

polysiloxane material, may hypothetically reduce the permanent deformation of impression material determined by the stress between the material and impression copings created when an impression with the copings is removed from internal connection implants (32).

Wee et al. (5) studied the torque resistance of impression materials and reported that polyether material showed the greatest torque values, which may be favorable for the manipulation of a pick-up impression. Other materials, such as condensation silicone, polysulfide, reversible hydrocolloid, irreversible hydrocolloid, and plaster did not show improved accuracy compared to either polyether or VPS.

With proper material selection and manipulation, accurate impressions can be obtained for fabrication of tooth implant supported restorations. Most of the impression materials available today provide superb accuracy if they are manipulated correctly. Although VPS materials are likely to be more accurate than other materials, differences in accuracy (assuming correct manipulation) are likely not clinically significant.

Factors Affecting the Implant Impression Accuracy

Coping Modification

Liou et al. (22) found that the impression copings with different designs showed a different level of impression accuracy. To increase accuracy, the coping was extended or treated with airborne-particle abrasion and impression adhesive (33-35). However, the same surface treatment did not increase the accuracy in another study (32). Acrylic resin transfer caps and Gold machined castable abutments have been introduced to achieve better accuracy (36,37). Lee et al. (30) found that adding a 4-mm piece of the impression coping as an extension on the original impression coping compensated for the inaccuracy of subgingival placement of the implant. These modifications may lead manufacturers to develop new impression coping designs to enhance the accuracy of the impression.

Vigolo et al. (37) evaluated in vitro the accuracy of definitive casts obtained from transfer impressions using square copings for the replacement of one tooth. In the first group, nonmodified square impression copings were used; in the second group square impression copings previously airborne-particle abraded and coated with manufacturer-recommended impression adhesive were used. It was observed that displacement abutment positions in the specimens were significantly smaller in casts obtained from modified transfers than nonmodified transfers.

Angulation

Two studies reported less accurate impressions with angulated implants than with straight implants using

an experimental cast with 4 or 5 implants (29, 38). On the other hand, 2 other studies that used 2 or 3 implants reported no angulation effect on the accuracy of impressions (24, 39). When multiple implants are placed with different angles, the distortion of the impression material on removal may increase. Also, this effect may be heightened by an increasing number of implants. To determine the relation between the angulation effect and the numbers of the implant, more studies are required. Other studies (30, 40) examined the effects of various factors on the accuracy of implant impressions, such as different connection levels (implant level and abutment level), different impression trays, implant depth, and time delay for stone pouring. The studies (30, 40) were too few to draw any conclusions. Further studies, including clinical trials, are required to provide more evidence about the factors that affect the implant impression accuracy.

Conclusions

A review of studies of accuracy of implant impression techniques revealed that more studies reported greater accuracy of implant impressions with the splint technique than with the nonsplint technique. For situations in which there were 3 or fewer implants, most studies showed no difference between the pick-up and transfer techniques, whereas for situations in which there were 4 or more implants, more studies showed more accurate impressions with the pick-up technique (open tray) than the transfer technique (closed tray). Polyether and VPS were the recommended materials for the implant impressions. Results indicated that the 2-step VPS impression was significantly less accurate than the 1-step putty and light-body VPS combination impression, the medium-body VPS monophasic impression, and the medium-body polyether monophasic impression.

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