

## **Evaluation of the methods used for impression making for different implant systems in prosthetic dentistry**

### ***Avaliação dos métodos usados para moldagem em diferentes sistemas de implantes em prótese dental***

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#### **ABSTRACT**

Fabrication of an implant supported fixed or removable-partial-denture requires precise transfer of the intra-oral structures and the implant components to the plaster model. With the increase in the number of implant systems, impression making procedures also increased depending on each system. This article summarizes and describes the procedures and factors that affect adequate impression making for several implant systems based on the information from English peer-reviewed journals identified by a Medline search covering the years from 1979-2005, text books, and the information obtained from the manufacturers of the most commonly used implant systems.

Clinical relevance: since impression making methods vary depending on each implant system, clinicians should study the procedures for each system in order to achieve successful implant supported fixed- or removable-partial-dentures.

#### **UNITERMS**

Dentistry; implant, implant systems, impression materials.

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#### **INTRODUCTION**

Impression can be defined as the record or the negative of an object. Impression in dentistry includes placing a soft or a semi-soft material into the oral cavity and removing this material after the impression

sets. By recording the abutment teeth and the environmental soft tissues, positive reproductions (models) are cast. In prosthetic dentistry, making impressions of the oral or maxillofacial tissues accurately and their precise casting of the models are of great importance for subsequent successful restorations.<sup>20,43-4</sup>

Ideal impression materials should have low viscosity and the viscosity degree should be under the control of the clinician. They should become plastic at temperatures that could be tolerated by the oral tissues. While removing from the mouth, they should not exhibit distortion. They should be able to record the tissues in detail. In order to make the clinical procedures easier, impression materials should harden in a reasonably short time ranging between one to six minutes. An ideal impression material should not expand, contract or warp to any appreciable degree at ordinary temperatures, have no negative effect on tissues and have nice odor. It should be possible to make additions when necessary. They should be prepared in a simple way and have the properties to be able to set in mouth temperature while also presenting the least dimensional changes. They should not show distortion when casting material is poured and not affected from the chemical structure of the casting material.<sup>43-4</sup>

Prosthetic dentistry has entered a new era with the successful use of implants. Particularly in implant prosthodontics, the precise impression methodology would decrease the failures experienced related to the suprastructure fabrication. This article describes the procedures and factors that affect adequate impression making for several implant systems.

## MATERIALS AND METHODS

Information is supplied from English peer-reviewed journals identified by a Medline search covering the years from 1979-2005, text books, and the manufacturer sources from the most commonly used implant systems.

## RESULTS

Impression materials have different physical and chemical properties. They could be generally classified as follows:

### Reversible (Elastic) impression materials

Softening and hardening of these materials take place by physical means. Structures of the primary material and its resultant products do not present any chemical differences. They are rendered plastic by heat, harden on cooling and can be used several times like agar-agar materials, starch, impression compounds.

### Irreversible (Inelastic) impression materials

In these materials, setting takes place chemically and the structure of the product material differs from the primary material. They are rendered plastic by the addition of a liquid, harden by crystallization and are used for once such as plaster, zinc oxide eugenol, polysulphide, silicone based materials, irreversible hydrocolloid. In recent years, while making impressions for implant overdenture prostheses, there is an increase in using elastomeric impression materials, namely, polysulphide based materials, silicone-based materials such as conventional silicones and polyvinyl siloxane and as well as polyether-based materials.<sup>20,43-4</sup> They could be summarized as follows:

### Polysulphide-based impression materials

Polysulphide, also known as thiocol or mercaptane, is an elastomer. It is the product of an exothermic polymerization reaction, resulting from the mixture of the base and the catalyst. Polysulphide is hydrophobic in nature and could be affected from moist or a rise in temperature, thus the model should be poured within an hour. When big undercuts are present, distortion could take place after removal.

### Conventional (Condensation Reaction) silicones

It is the product of a reaction, resulting from the mixture of the liquid silicone polymer base and the organo-tin catalyst. These two materials are cross-linked by a reaction between terminal hydroxyl groups on the polymer and ethyl orthosilicate. When this reaction ends, shrinkage of the material starts with the evaporation of the alcohol. Thus, its dimensional stability is low and the metal should be poured as soon as possible. There are some condensation silicone materials that utilize a heavy-body 'putty' relined with a thin 'wash'. They are developed in order to reduce the sizable dimensional change that occurs when material is not poured immediately. The putty has a silica filler content of 75% that is twice more than that in the wash.<sup>44</sup>

### Polyvinyl siloxanes (Additional Silicones) impression materials

Polyvinyl siloxanes were introduced in the dental market in 1980ies. The material is usually packaged in two pastes. While one paste contains silicone with terminal silane hydrogen groups and inert filler, the other paste consists silicone with terminal vinyl groups, chloroplatinic acid catalyst and filler. Upon mixing

of these two materials, there is an addition of silane hydrogen groups across vinyl double bond without any formation of by-products. It has high dimensional stability and is least affected when poured in delays, or by second pours. It is still accurate even when it is poured 1 week after removal from the mouth. Putty and light-body 'wash' consistencies are arranged for this type of silicone as well.<sup>44</sup>

### **Polyether-based impression materials**

This elastomeric impression material has become popular in the last 25 years. It is a copolymer of 1,2 epoxyethane and tetrahydrofuran that reacts with an  $\alpha$ ,  $\beta$  unsaturated acid, such as crotonic acid to produce esterification of the terminal hydroxyl groups. The double bonds are reacted with ethylene amine and the final polymer is formed. An aromatic sulfonate produces crosslinking by cationic polymerization. It exhibits accuracy on par with, or somewhat superior to, that of elastomers. It is also accurate when poured 1 week after removal from the mouth. As polyether has an affinity for water, impressions made of this material should not be stored in a humid or moist environment.

### **Impression tray types**

The precision in fabrication of prostheses that is proper for the tissues to be restored is also dependent on the tray type.<sup>11</sup> Custom tray fabrication procedures involve anatomic impression using a standard tray and casting of a diagnostic model. Diagnostic model is then covered with two sheets of baseplate wax to prepare space for the impression material. In order to stabilize the custom tray, tissue stops are prepared by removing the wax from the postdam area and the incisal edges of the incisors in the upper tray. For the mandibular tray, stops are placed in the buccal shelf area and the tips of the canines. In general, autopolymerizing or light-polymerized acrylic resin materials are used to fabricate custom trays.<sup>14,41,43-4</sup>

Fabricating custom trays have the advantages of avoiding thick impression material since they fit properly on the residual ridges in the edentulous regions and also the arch in the dentate regions. By fabricating the custom tray 1 or 2mm shorter than the mobile tissue border, functional recording of the movement of mobile tissues and also border seal are achieved. Furthermore, creating relief with wax helps the impression material to distribute evenly and set in desired thickness. Preparing stops aids the tray not to be pressed into the soft tissues and remain stabili-

zed.<sup>14,41,43</sup> When these advantages are considered, cast models obtained from impressions with custom trays present higher accuracy with respect to the impressions obtained with standard trays.<sup>4,14,31</sup>

### **Prosthetic treatment with the implants**

In conventional prostheses, support is gained from the abutment teeth, alveolar ridge and the soft tissues. In implant prosthodontics, since support is obtained from the implants to avoid alveolar bone resorption, mastication effectiveness, adaptation of the prostheses and patient satisfaction are also increased.<sup>34</sup> In recent years, the advantage of using osseointegrated implants for partial and total edentulous patients has been proved scientifically.<sup>6</sup>

In implant prosthodontics, passive fit of the suprastructures onto the abutments and/or implants are of great importance.<sup>46,51</sup> Any faults occurred during impression making procedures in the clinic may lead to false analogue positioning and prosthesis fabrication in the laboratory that may result in prosthetic complications like uneven force distribution, prosthesis and/or abutment screw loosening and occlusal discrepancies.<sup>51</sup> For this reason, intraoral position of the implant and its relation to the abutment connection must be recorded and transferred to the impression accurately so that precise cast models could be made.<sup>36</sup>

While making impressions, elastomeric materials such as additional silicone and polyether should be of choice.<sup>9</sup> Carr et al.<sup>9</sup> showed that a rigid elastomeric impression material, like polyether, would secure the impression copings accurately, has dimensional stability, high resistance to permanent deformation, high primary shear resistance with little creep under compressive forces that makes it an optimal material to be used for making impressions of the implants. Hung et al.<sup>25</sup> found that the material type was more important than the impression method when additional silicone is used as an impression material.<sup>25</sup> In the same study, additional silicone with one and two step putty/wash methods did not show any difference in accuracy when two impression methods were compared. Studies also revealed that using custom trays improves the impression accuracy in implant suprastructure fabrication.<sup>2,7,10,24,38,45</sup>

While making impressions from implants, two types of trays can be used:

### **Indirect method (Closed tray method)**

Following placing the impression copings onto the implants, impression is taken with standard trays. After

the material is set, it is removed from the patient's mouth. Impression transfer coping is then removed from the mouth, attached to its analogue and placed into the impression again. When this method is employed, impression material surrounding the impression copings will be thick, thereby more resistant to the displacing forces that often occur when impression is being removed from the mouth (Figure 1-3). When

compared with the direct method, clinical procedures are considerably simpler and any rotations that could occur in direct method while loosening the copings and eventually the resultant distortion are avoided. However, after replacement of the copings into the impression, distortions are inevitable. When a standard tray is used, the impression material cannot have an even distribution and thickness.<sup>2,7,10,24,38,45</sup>



FIGURE.1. A, Pick-up coping and positioning cylinders are stabilized in the Straumann implant system. B, Impression made with the closed tray direct technique. C, Implant analogs placed in the positioning cylinders.



FIGURE.2. A, Impression copings fixed on the Frialit implants. B, Transfer copings placed onto the copings. C, Impression made at the implant level with the closed tray technique.



FIGURE.3. A, Impression copings fixed on the Camlog implants. B, Transfer copings placed onto the copings. C, Impression made at the implant level with the closed tray technique.

**Direct method (Opened tray method)**

In this method, impression copings are placed onto the abutments and access holes are prepared on the fabricated custom impression tray in order to gain access for the copings. Using an accurate impression material and square or screw type of impression copings, the impression is made. First, impression

copings are screwed tightly onto the implants and then access holes are prepared on the tray for implant copings to extrude from the custom tray during the impression procedure. After the impression material is set, impression coping screws are loosened and the impression is removed from the patient's mouth (Figure 4,5).



FIGURE 4. A, Impression copings fixed on the Astra implants. B, Custom made tray for open tray technique. C, Impression made at the implant level with the opened tray technique.



FIGURE 5. A, Impression copings fixed on the Swissplus implants. B, Impression made with open tray method. C, Implant analogs placed in the impression.

The advantage of using a custom tray is that adequate space is created for the impression material. Thus, material will be evenly distributed and shaped, owing to the desired thickness. When resilience of soft tissues is considered, tissue stops would help the tray be stabilized and pressed on the soft tissues. However, opened tray method has also some limitations; during the impression procedure, screw loosening could be experienced that exhibits a challenge for the clinician. When splinting is not performed, copings may rotate while unscrewing before the removal of the impression from the mouth. Preparing large-diameter access holes

on the custom tray would decrease the pressure and result in uneven distribution of the impression material around the implants and on the soft tissues.<sup>2,7,10,24,38,45</sup>

In some studies comparing direct and indirect methods for dimensional stability of cast models, direct method was found to be more accurate,<sup>2,9,38</sup> while others found more favorable results with the indirect methods.<sup>7,24</sup> However, Spector et al.<sup>45</sup> and Carr et al.<sup>14</sup> demonstrated that the two techniques did not differ from each other. As for impression trays, Gordon et al.<sup>21</sup> concluded that impressions with custom trays delivered more accurate results when compared with the standard

impression trays.<sup>21</sup> On the other hand, Eames et al.<sup>18</sup> 1979, reported that elastomeric impression material exhibiting varying thickness in the standard tray would be the major reason for incorrect impressions.<sup>18</sup>

Recently, manufacturers developed a method where newly designed copings are used in a so-called 'snap-on' method. In this method, impression copings are placed on the transmucosal neck of the implants through positioning cylinders and left in the impression without using the screwing system.<sup>1</sup> The advantages of both direct and indirect methods are combined in one simple system.

Stabilization of positioning cylinders and impression copings cannot be achieved during impression removal. In implant prosthodontics, therefore impression procedures can be followed at two stages after the surgery namely, at the abutment and the implant level:

### Abutment level

At the abutment level, a direct impression method is used. After the healing caps are removed and abutment is placed on the neck of the implant, abutment is prepared according to the tooth preparation principles. Impression is then made from the prepared abutment in the mouth following the conventional impression procedure and sent to the laboratory where suprastructure is cast in the model (Figure 6, 7). By this way, impression procedure becomes very simple. In single implant restorations, relation between the abutment and the teeth could be established by the clinician instead of the technician. In order to obtain precision during the laboratory steps, making impression at the abutment-level is not recommended.<sup>15</sup>



FIGURE 6. A, Impression copings fixed on the Astra abutments. B, Abutments and impression copings. C, Impression made with the opened tray method at abutment level.



FIGURE 7. A, Straumann abutments placed on the implants. B, Impression copings placed on the abutments. C, Impression made with the closed tray method at abutment level

### Implant level

In single tooth implant cases, either direct or indirect technique is recommended at the implant level as described above.<sup>15</sup> For impression copings, screw type or plastic copings are used. Implant level impressions provide simplicity during provisional restoration fabrication,<sup>23</sup> allows selecting the proper abutment in the laboratory<sup>28</sup> and it is possible to prepare adjustable or custom-made abutments.<sup>39</sup> These are the great advantages of implant level impressions when compared with abutment level impressions (Figura 1,5).

### Splinting procedure

Before making the impression of multi-unit implant restorations, in order to decrease the amount of distortion and to improve impression accuracy and implant stability, splinting procedure is recommended either using direct or indirect impression methods.<sup>3</sup>

Splinting of the abutments or transfer copings stabilizes the impression copings under the applied torque force during analog screw tightening (Figura 8). Rotational movement of impression copings in the impression material is also avoided. Apart from these advantages, splinting has an important role in the accuracy of the model fabrication.<sup>3</sup> Brånemark et al.<sup>5</sup> compared the accuracy of impression materials and found that splinting the transfer coping delivers better results than not splinting. Splinting can be achieved by using tooth floss<sup>5</sup> or orthodontic wires in the construction of the substructure and by placing the prefabricated acrylic rings between the copings.<sup>40</sup> Impressions made from direct impression copings presented better results when compared with the repositioned impression copings.<sup>9</sup> While analog screw tightening in the direct unsplinted method, rotation of square type of impression copings was observed.



FIGURE 8. A, Splinting of implants with dental floss and acrylic resin. B, Splinting of implants with orthodontic wire. C, Impression made with opened tray technique at implant level

### Impression making in different implant systems

In each implant system, different impression methods are recommended:

#### Straumann implant system

Straumann implant system (Institut Straumann AG, Waldenburg, Switzerland) recommends ‘snap-on’ impression method and consists different abutment types both for screwed or cemented restorations. With the Straumann System, according to preference, impression could be made at the abutment or the implant level.

#### Abutments and transfer copings

**synOcta Abutment:** “Regular Neck” and “Wide Neck” options are available that can be used for

both screwed or cemented systems. In situations where angled implant axes are restored with screw type of systems, angled “Regular Neck” abutment is used.

**Solid Abutment:** “Regular Neck” and “Wide Neck” abutment types could be used for impression making of cemented suprastructures and also for impression making at the abutment level.

**synOcta Gold Abutment:** This abutment is designed for establishing precision in the regions where esthetic is concerned and it allows for casting of suprastructures.

**Snap-on Impression Coping and Impression Cylinder:** They supply space for impression cylinders for ‘snap-on’ impression method.

**Esthetic CeraOne Abutment:** It is used in the anterior regions since it is preferred for its translucency especially when they are used in combination with full ceramic restorations.

### Impression making in Straumann system

Gingiva former is removed from the mouth to have access to the neck of the implant. 'Pick-up' coping is placed onto the transmucosal neck of the implant and positioning cylinders are stabilized until a 'click' sound is received. Impression is made using the closed tray technique. Impression cylinders and 'pick-up' impression copings are left in the impression (Figura 1,7).

### FRIALIT-2 implant system

In FRIALIT-2 implant system (Friatec AG, Mannheim, Germany), implant-level impression making is recommended instead of abutment-level impression and for this reason screw type of transfer copings are designed. In this system, using different abutment types, direct impression method is advised. Six types of abutment types are available:

#### Abutment Types

**Esthetic Base:** It is designed for single and multiple-unit restorations. They are available in 1-3mm gingival profile heights and could be either cemented or screwed from the lingual side. Clinicians could select the proper abutment according to the gingival height and modify it for the patient.

**Auro Base:** This abutment type can be customized according to gingival profile height in both suprastructure fabrication and in angled/inclined situations.

**Cera Base:** This abutment is designed for the restoration in the anterior region where high esthetics is of importance.

**MP Classic:** They are fabricated for occlusal screw type or full mouth restorations and have 1 to 5mm gingival profile height. Occlusal screw tightens both the suprastructure and the abutment together.

**Telescope Abutment:** This is a basic suprastructure for single unit restorations with occlusal screw type of abutments and for maxillary edentulous cases restored with four implants. Telescope abutments are prepared in the dental surveyor and mounted in the denture.

**Ball and Socket Attachment:** They are simple attachments, can be easily cleaned and could be considered as alternatives for fixation of mandibular dentures. They are also available for 1 to 5mm gingival profile height.

### Impression making in FRIALIT-2 system

First, the gingiva former is removed, proper impression coping for the implant diameter is chosen and fixed on the implant using a screw. Transfer copings are then placed onto the copings in order to improve the impression precision. Impression is made using the direct method. Through the access holes created in the custom tray, transfer copings are unscrewed and kept in the impression. Implant analogues are then fixed onto the transfer copings (Figura 2).

### CAMLOG implant system

In CAMLOG implant system (Camlog Biotechnologies AG, Basel, Switzerland), transfer copings are fabricated for direct and indirect impression methods. Copings are designed to be used either at the implant or the abutment level. Plastic transfer copings do not exist in this system. All transfer copings and abutments are screw type of copings or abutments.

#### Abutments and transfer copings

**Laboratory and Impression Copings:** Screw type of copings are developed both for open and closed tray techniques. According to preference, either direct or indirect impression methods could be used.

**Provisional Abutment:** These abutments are used with screw system for provisional restorations. They are available in 3.8, 4.3, 5 and 6mm diameters.

**Ball Abutment:** It is used for overdenture prostheses with gingival profile heights of 1.5, 3 and 4.5mm.

**Bar Abutment:** It is designed for overdenture prostheses with gingival profile heights of 0.5, 2 and 4 mm.

**Universal Abutment:** It is developed for abutment level impressions in all cases for all regions. Height of profile is established in the dental laboratory.

**Standard Abutment:** Two types of standard abutments are available in gingival profile heights of 1.5 and 4mm.

**15° Angle Standard Abutment:** They are available in 1.5 and 4mm gingival profile heights, specified for implants that are angled properly for suprastructures.

**Esthetic Abutment:** It is used in anterior regions where esthetics is of importance. They have 1.5 and 4 mm of gingival profile heights.

### Impression making in CAMLOG system

**Abutment level:** Abutment is shortened with a hand piece and screwed onto the implant. Margins are prepared intraorally like in FPD prepara-



tion and conventional impression procedures are followed.

**Indirect method at implant level:** Implant abutment is screwed to the neck of the implant. Impression is made with a standard tray. Unscrewed abutment is repositioned in the impression.

**Direct technique at implant level:** Transfer copings are developed for direct impression technique. They are screwed onto the implant and impression is made with a custom tray. Through the access holes, transfer copings are loosened and kept in the impression (Figura 3).

### ASTRATECH implant system

In ASTRATECH implant system (Astra Tech AB, Mölndal, Sweden) 'snap-on' type of impression making is recommended. However, the system also consists copings to be used for the impression at the abutment level.

### Abutments and transfer copings

**Direct Abutment:** Direct abutments, designed for 'snap-on' impression method are available in 0.5, 1, 2.5 and 4mm gingival profile heights. They also allow for intraoral preparation before impression making at the abutment level.

**Profile Abutment:** These abutments are available in 0.5, 1, 2.5 and 4mm gingival profile heights that are suitable for situations where high esthetic outcome is considered.

**Cast-to Abutment:** They are in gingival profile heights of 0.5, 1, 2.5 and 4mm generally being used for multi-unit implant restorations.

**Pick-up Cap:** After they are stabilized on the abutment, 'snap-on' impression method is applied.

**Healing Cap/Burn-out Cylinder Cap:** They are designed for fabrication of provisional restoration and also used during the healing period.

### Impression making in ASTRATECH system

Depending on the gingival height profile, proper abutment is selected and fixed on the abutment. Impression is made with open or closed tray technique (Figura 4). Closed tray technique is advised and pick-up impression coping is kept in the impression.

### SWISSPLUS implant system

In SWISSPLUS implant system (Zimmer Dental, Carlsbad, USA) by using indirect technique, impression making either at the abutment or the implant level is

recommended. For direct impression method, screwed restorations, appropriate abutments and replicas are all included in the impression. All impression copings and abutments in this system are in screw type design. The abutment types in this system are as follows:

### Abutments and transfer copings

**Transfer Copings:** They are available in 4.6, 5.2 and 6mm gingival profile height. Screw type of transfer copings are fabricated for indirect impression method.

**Straight Abutment:** After the intraoral preparation, this type of abutment is used in indirect impression making at the abutment level or after being fixed to the implant that serves as an impression coping. They are available in 3.5, 5.2 and 6mm gingival profile height.

**20° Angled Abutment (Zimmer's):** This abutment type is specified for anterior regions where esthetics is considered. It recommends use it after the intraoral preparation with abutment-level impression method or after being fixed to the implant as an impression coping with indirect impression method. They are available in 4.6 and 5.2mm gingival profile height.

**'Cast-to' Gold Abutment:** These screw type of gold abutments come in 4.5 and 5mm gingival profile heights with plastic copings for cast suprastructures.

**ACT Transfer Caps:** These caps are developed for multi-unit screw type implant restorations. Either direct or indirect impression technique could be applied. They have also alternatives for suprastructures, like plastic and gold copings.

**Ball Abutment and Attachment:** This special abutment and its analogue are used for overdentures.

**ZAAG Abutment and Attachment:** It is specific for the fabrication of suprastructure in the overdenture prostheses in 1.5 and 2.5mm height.

### Impression making in SWISSPLUS system

**Abutment level:** Abutment is shortened with the hand piece and screwed to the implant. Margins are prepared intraorally similar to a preparation for an FPD and then conventional impression procedures are followed.

**Indirect method at implant level:** Implant abutment is screwed to the neck of the implant. Indirect impression is made with a standard impression tray. Unscrewed abutment is then repositioned in the impression.

**Direct method at implant level:** Transfer copings, developed for direct impression method, are screwed

onto the implant. Impression is made with a custom tray. Through the access holes, transfer copings are loosened and kept in the impression (Figure 5).

## DISCUSSION

Research findings on the impression making procedures for implant supported fixed or removable fixed-partial-dentures are based on the impression material, impression method, splinting and the type of modified impression copings. The effects of these factors have resulted in different research outcome:

### Impression material

In one study, impression making with a stock tray using polyvinyl siloxane was found to be an efficient and cost-effective method.<sup>1</sup> Also, in the same study, using polyether and polyvinyl siloxane did not show significant differences. In another study, Daoudi et al.<sup>15</sup> did not find significant differences between polyvinyl siloxane (light and heavy body) and polyether impression materials for the accuracy.<sup>15</sup> When the double-mix technique was used, polyether and additional silicone were found equally good with regard to precision. Furthermore, polyether and additional silicone impression materials demonstrated no significant difference between two methods where transfer caps were used.<sup>29</sup> On the basis of an analysis by Wee<sup>49</sup>, implant casts made from polyether (medium) or additional silicone (high) impression materials presented significantly less casting error than those made from polysulphide impression material.<sup>49</sup> The findings of this study suggest the use of polyether for making impression from completely edentulous cases where multiple implants are indicated. Herbst et al.<sup>22</sup> stated that two-stage addition-reaction silicone-based impression material has properties that ideally suits for coping transfer, capable of providing sufficient rigidity, preventing rotation of square impression copings during analog tightening and forming the casts.<sup>22</sup> Thus, when such materials are used, splinting may not be necessary.

### Impression method and trays

In one study, similar in outcome was found when direct impression method was used in combination with polyether with direct method and indirect method with polyvinyl siloxane.<sup>1</sup> Moreover, snap-on technique used in the ITI system utilizing a stock tray and polyvinyl siloxane material was found to be an effective

method with positional and angular accuracy.<sup>1</sup> Daoudi et al.<sup>15</sup>, on the other hand, stated that, "pick-up" impression method at the abutment level was more predictable than the repositioning impression method at the implant level.<sup>15</sup> In other studies, polyether and addition reaction silicone, in combination with the use of acrylic resin transfer caps were advised for transfer procedures when Frialit-2 system was employed.<sup>22,29,49</sup> The study by De La Cruz et al.<sup>16</sup> observed significantly more distortion with the open tray technique than those of resin-splinted situations or when closed tray technique in vertical plane was used.<sup>16</sup> One study on the trays demonstrated that plastic dual-arch tray produced more accurate working dies in buccolingual dimension than metal dual-arch tray. Besides, it was stated that custom tray was not shown to differ from dual-arch trays in accuracy and all three types of impression trays produced dies having adequate clinical standards to make clinically successful impressions of a single tooth implant abutment.<sup>12</sup> Burns et al.<sup>8</sup> reported that when vertical fit discrepancy was measured, both rigid custom close-fit trays and spaced custom trays produced significantly more accurate impressions than flexible polycarbonate stock trays.<sup>8</sup>

### Splinting

Assif et al.<sup>3</sup> compared polyether impressions, splinted with autopolymerizing acrylic resin, dual-cure acrylic resin and impression plaster and reported that dual-cure resin splinting method exhibited the highest distortion.<sup>3</sup> When average deviation of distortion was evaluated, unsplinted tapered copings demonstrated less distortion than unsplinted square type of copings and copings with unsplinted square type with lateral extension.<sup>22</sup> The accuracy provided by different resins for jig fabrication was not found superior compared to standard impression procedures.<sup>16</sup> On the other hand, the use of auto-polymerizing acrylic resin for splinting was found to be more necessary instead of using unconnected impression copings in order to obtain accurate master casts.<sup>48</sup> It was also suggested that the direct splinting technique was the most accurate transfer method for multiple abutments compared to direct non-splinted indirect impression making methods.<sup>33</sup> Direct non-splinted and indirect impression techniques also resulted in similar transfer deformation. It was further stated that in implant cases with divergent angulations, it might be preferable to use square impression copings that are previously airborne-particle abraded and coated with an adhesive.<sup>47</sup>

### Modified impression copings

In the study of Vigolo et al.<sup>48</sup>, accurate master casts were obtained with air-particle abraded impression copings that were coated with an adhesive recommended by the manufacturer.<sup>48</sup> The results on mean cast accuracy did not differ from that of square impression copings splinted with auto-polymerizing acrylic resin. In agreement with their previous research,<sup>47</sup> Vigolo et al.<sup>48</sup> also indicated that casts retrieved from transfer impressions with non-modified air-abraded and adhesively coated impression copings were less accurate than those of the casts obtained from square impression copings that were joined together with auto-polymerizing acrylic resin prior to the impression procedure.

There are also alternative procedures in impression making for implant-supported prostheses. They include modifying impression copings (i.e. air-particle abraded, acid etched), splinting of impression copings, using different impression material, using fabricated custom tray, applying direct, indirect or snap-on impression methods.

Runghcharassaeng et al.<sup>42</sup> fabricated a stable record base for an edentulous model by using healing abutments and eliminated the necessity of healing abutment removal and its consequences.<sup>42</sup> Thus, clinical and laboratory procedures were simplified and try-in phase was more accurate. Dumbrigue et al.<sup>17</sup> used prefabricated acrylic resin bars to decrease the negative effects of polymerization shrinkage on impression making.<sup>17</sup> Williamson et al.<sup>50</sup> used an easy, inexpensive method, with polyvinyl siloxane to measure the interocclusal distance to aid in proper selection of implant prosthetic components.<sup>50</sup> Chaimattayompol et al.<sup>13</sup> presented an impression procedure that used either prefabricated screw-retained titanium implant index copings (if necessary they could be modified) or plastic snap-on implant index copings to solve problematic implant placement.<sup>13</sup> Matsushita et al.<sup>30</sup> modified a custom tray by preparing buccal windows for direct impression method in order to make a clear impression of the soft tissue around the implants.<sup>30</sup> Mirfazaelian<sup>32</sup> described a time-saving technique for multiple-implant restorations in which abutments were marked, removed from the mouth and through these markings they were positioned on the working cast after the impression is made.<sup>32</sup> Ku et al.<sup>26</sup> presented a simple block-out method in which a small rubber dam ring was placed around the abutment before the pick-up procedure.<sup>26</sup> Nissan et al.<sup>35</sup> demonstrated an implant impression technique for partially edentulous

patients in which impression plaster and irreversible hydrocolloid were used to ensure accuracy and ease of manipulation and at the same time decrease working time.<sup>35</sup> In the study of Kuo et al.<sup>27</sup>, a procedure for fabricating an optimal emergence profile for the definitive restoration of subgingivally installed implants with the modification of the impression cap was described.<sup>27</sup> Another method was introduced for making implant impressions with reduced framework misfit in which two-stage impression method was applied that combined the use of plaster and polyvinyl siloxane.<sup>19</sup> Petridis<sup>37</sup> applied a method that utilized plastic burnout abutments for recording maxillomandibular relationship.<sup>37</sup> With this technique, definitive impression could be made for unilateral or bilateral distal extension situations at the same appointment.

### CONCLUSIONS

Implant model accuracy could be dependent on the type of the impression material, transfer coping, splinting of these copings and the impression method applied. Impression methods in implant prosthodontics could be either, indirect, direct or direct-splinted methods. When these methods were compared, the accuracy of the direct method was found to be higher and indirect method has shown the highest average distortion value. In direct method, the impression material to be used should be able to stabilize the direct transfer coping and avoid its displacement at the time of the abutment placement. It should also minimize the potential positional distortion that could occur between the abutment replicas and the intraoral implant abutments.

Custom trays with high accuracy should be preferred when making impressions. When light-polymerized and auto-polymerized acrylic resin trays were compared, preparation of light-polymerized acrylic resin trays was considered less time consuming. Also light-polymerized acrylic resin trays showed higher dimensional stability than custom trays. When acrylic resin custom trays are used, spacer thickness and access hole should be increased. By this way, the applied pressure at the time of impression making was found to be equal. Therefore, when making impressions for implant overdenture prostheses, additional silicone and polyether impression materials should be used. Polyether-based impression materials present flexible property under compressive forces and presents acceptable hardness values. Thus, the use of polyether is advised in multiple-unit implant restorations.

Increasing order of applied pressure values according to impression material types is polyvinyl siloxane

(medium body), polyether, polyvinyl siloxane (light body) and polysulphide.

## RESUMO

*A fabricação de prótese total ou fixa suportada por implantes requer precisa transferência das infra-estruturas e dos componentes dos implantes para um modelo de gesso. Com o aumento no número de sistemas de implante, as técnicas de impressão também aumentaram, o que depende de cada sistema. Esse artigo resuma e descreve os procedimentos e fatores que afetam a adequada moldagem em diversos sistemas de implante baseado em informações de artigos completos em inglês de revistas indexadas no Medline entre os anos de 1979 e 2005, livros-textos, and em informações obtidas a partir dos fabricantes dos sistemas de implantes comumente usados.*

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*Odontologia, implante, sistemas de implante, moldagem*

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