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DENTAL IMPLANT IMPRESSION TECHNIQUES: REVISITED

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ABSTRACT

A key factor to success and longevity of implant prosthesis is an accurate fit which can be achieved through a proper impression technique. Several impression techniques have been proposed to provide a cast that will ensure accurate fit of prostheses on Osseo-integrated implants. These include abutment level impressions, indirect (closed tray) and the direct (open tray) techniques for implant level impressions and splinted and non-splinted technique for open tray impressions. Out of the available materials, polyether and vinyl polysiloxane are commonly used for impression techniques. Whereas, for splinting copings for open tray technique materials like resin, plaster, wax and others have been suggested. However, each clinical situation demands a proper technique requiring minimal time, easy to perform, inexpensive, comfortable for the patient and with best results which calls for a thorough understanding of various impression materials and techniques for their best utilization.

KEYWORDS: Dental implants, open tray, closed tray, digital impressions.

INTRODUCTION

Dental implants have become a common means for replacing single or multiple missing teeth. Wide variety of implant and prosthesis materials are available commercially. Various factors play an important role in the long-term success of an implant. One of the key factors in maintaining longevity is the passive fit of implant prosthesis. The discrepancies in passive fit of prosthesis may lead to complications such as screw loosening, screw facture, occlusal discrepancies, increased plaque accumulation, resulting in loss of osseointegration and implant fracture.[1] Implant impression is an important step in achieving passive fit by accurately relating an analogue of the implant or implant abutment to the other structures in the dental arch. Further the accuracy of impression is affected by the selection of impression tray, impression technique and type of impression material, number and angulation of implants.[1]

Several impression techniques have been proposed to provide a cast that will ensure accurate fit of prostheses on Osseo-integrated implants.

Implant level impressions[2]

There are two primary techniques for implant level impressions:

- The indirect (closed tray) technique and
- The direct (open tray) technique.

The direct technique may use:

- Splinted or
- Non-splinted implant impression copings

Abutment Level Implant Impression[3]

If there is a requirement to replace old implant supported crown, abutment level impression is indicated just like crown and bridge cases.

When fabricating implant supported fixed dental prostheses (FDPs), the accurate reproduction of implant position on the definitive cast is essential. The definitive cast has to represent 3- dimensional (3D) orientation of the implants in position. The precision of definitive cast is essential for fit of an implant-supported FDP and a precise impression technique is needed to produce an accurate implant position on the definitive cast.[4]

The accuracy of impressions is affected by[4]

- Splinting impression copings,
- Implant angulation,
- Number of implants,
- Polymerization shrinkage of the impression material,
- Setting expansion of the dental stone,
- The design and rigidity of the impression tray

Among all possible factors affecting the accuracy of impressions, splinting or not splinting seems to be the most significant in cases of multiple implants.[4] Several authors advocate connecting impression copings together intraorally prior to impression making with acrylic resin to provide the best result. However, other studies demonstrated that this splinting process is unnecessary.[2] During splinting, distortion of splint materials and/or fracture of the connection between splint material and impression copings may affect accuracy. Also, polymerization shrinkage of auto-polymerizing acrylic resin produces inaccuracy in the definitive impression. This shrinkage ranges between 7% and 9%, with 80% occurring within 17 minutes when materials were mixed at room temperature.[4]

There are a variety of materials that can be used to splint copings such as composite resin, plaster, or acrylic resin,[5] scaffold of dental floss and prefabricated acrylic resin bars and wax.[6] Polyether and vinyl polysiloxane impression material are commonly used for impression techniques.[2]

Closed Tray Vs Open Tray

The design of transfer coping and the tray are the main differences between both techniques. Squared transfer copings and open tray are applied for direct transfer technique, whereas indirect technique is performed with tapered transfer copings and closed tray. The indirect technique maybe less difficult clinically; however, it has been shown to have greater instability in transferring the implant position. On the other hand, direct transfer technique with splinted impression copings exhibits greater transfer precision.[6]

In case of divergent implants, open tray impression (pickup impression) has to be opted for easy removal. However, in less mouth opening, limited access areas (posterior) and severe gagging patients, closed tray impression technique is better choice. The accuracy of open tray impression technique is comparatively more as there may be chances of discrepancy during replacement of transfer coping in impression. However, some studies also prove that in case of fewer implants, closed and open tray impression techniques have no significant difference. When the number of implants is greater, clinician should opt open tray impression technique for more accuracy.[3]

Direct Impression techniques (Open tray, Pick Up)

A custom or stock open tray with access to the impression coping screws is required, which exposes the coronal ends of the impression coping.[7] The transfer post for an open tray technique includes square shaped post and a fixation screw for precise connection to implant.[8]

Open window on tray allows for the screws to be removed. The light body material is syringed to surround each transfer post.[7] The custom tray is then filled with putty and delivered over square transfer posts,[9] ensuring that guide pin of the impression coping is visible and protrudes through the hole in the tray.[7] Impression copings are unscrewed and they are removed from mouth together with the set impression.[7]

The implant analogues are connected to the copings using the same screw. Some precautions to be taken are: radiographically confirmed seating of impression coping to the implant and use vinyl gloves when elastomeric impression material is used. This technique can be used for single tooth restorations, multi-unit restorations and implant over dentures for either cement retained or screw retained prosthesis.[7] An advantage of this technique is that dentist can confirm the laboratory preparation and contour of the provisional prosthesis to achieve the desired healing and soft tissue contour before final crown fabrication.[7]

The direct technique can be further subdivided into:

- Splinted and
- Non-splinted techniques.

The splinting procedure is recommended in case of multiple implants to decrease the amount of distortion and to improve impression accuracy and implant stability. Splinting of transfer copings prevents their rotational movement in impression material during analog fastening, which provides better results than no splinting. Accuracy of a splinted impression technique depends upon its resistance to deformation under the forces of impression material; hence the use of rigid splint material is essential for accurate master cast.[7] Materials used to splint impression copings include light-curing composite resin, impression plaster, thermoforming material, acrylic resin, and auto polymerizing acrylic resin.[9]

Splint Technique versus Non-splint Technique[10]

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. Among the impression making methods presented in literature, splinted technique has gained popularity and has proven to be the most accurate.

Kim et al. investigated the accuracy of implant impression over multiple laboratory procedures and found that non-splint technique was more accurate

during impression-making procedure, while splint technique was more accurate during the cast fabrication procedure.

Akca et al. found that the positional and angular accuracy of ITI's snap-on impression technique using a stock tray with vinyl polysiloxane was acceptable and convenient for multiple implant transfer.[11]

Transfer Technique versus Pick-Up Technique[10]

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 inter-arch space, tendency to gag, or if it is too difficult to access an implant in the posterior region of the mouth. 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.

Splinted Impression Copings Procedure[12]

Impression copings were splinted with dental floss and auto-polymerizing acrylic resin. The transfer copings were tied up with four complete loops of dental floss and splinted with auto-polymerizing acrylic resin (pattern resin) and allowed to set for 3 minutes. Seventeen minutes after setting, the acrylic resin substructure and splinted transfer copings were removed from the framework and the splints were sectioned into four separate pieces with a hand piece diamond disk and a 0.2-mm standardized gap space was left between the single pieces. The square impression copings were then readapted to the implants in resin model and re-splinted with same acrylic resin. The impression procedure was then accomplished. The heavy consistency polyvinylsiloxane impression material was loaded inside the impression tray and light consistency polyvinylsiloxane impression material was meticulously syringed around the impression copings to ensure complete coverage of the copings. Implant analogs were fastened to the impression copings in the impressions. The impression was now poured to create a model.

According to a study done by Stimmelmayer et al, impression technique influenced the accuracy of implant transfer. Splinted pick-up technique showed significantly different results than transfer technique; the splinted pick-up technique was more favorable. Delivering of long-span prosthodontic rehabilitations came along with higher misfit in comparison to short-span rehabilitations.[13]

Stimmelmayer et al. observed that splinted pick-up technique showed significantly more accurate results than transfer technique, whereas no statistical difference between the splinted and non-splinted pick-up techniques was observed.[14]

A study done by Cabral et al. showed that direct impression technique with squared transfer copings with acrylic resin splints sectioned and welded after setting had better results than the other techniques studied.[5]

An in vitro study done by Assif et al concluded that an impression technique using rigidly interconnected impression copings via an auto-polymerized acrylic resin splint was the preferred method of impression making for implant-supported fixed restorations.[14]

In another study done by Assif et al it was found that impression techniques using auto-polymerizing acrylic resin or impression plaster as splinting materials were significantly more accurate than those using dual-cured acrylic resin as a splinting material.[15]

Indirect technique (closed tray)

An indirect technique is also known as closed tray impression technique. The copings are connected to the implant and after the removal of impressions they are retained on the implants.[12]

These copings are then removed from the implant, attached to the implant analogues and reinserted in the impression. Clinical situations which indicate the use of the closed tray technique, such as when the patient has limited inter-arch space, a tendency to gag, or if it is too difficult to access an implant in the posterior region of the mouth.[12]

Snap-fit (press fit) plastic impression coping

This technique uses press-fit impression coping which is connected to the implant by pressing instead of screwing and the plastic impression copings are picked up in the impression. This technique is not a pickup 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 impressions.[12]

Advantages[12]

1. Helps to overcome the movement of impression coping inside the impression material.
2. Time saving.

3. Has the advantage of both the open and closed tray implant impression techniques.
4. More comfortable for both the clinician and the patient
5. Easy to manipulate

The snap-fit technique may be a reliable impression making technique. But a study showed that although the errors measured were relatively small, there was potential for distortion with the transfer techniques used.[16]

Additional Impression Techniques[17]

Chaimattayompol et al note how time-consuming implant-level impressions abutment selection can be for the clinician when limited space, poor positions, or peculiar angulations are factors. They suggest the use of prefabricated screw-retained titanium implant index copings or plastic snap-on implant index copings when such conditions are present. Making impressions, they contend, is facilitated since both types of copings are easily modified.

Lorenzoni et al compared three different impression materials (polyether, polyvinyl siloxane, and hydrocolloid) and transfer caps with the Frialit(R)-2 system and with the indirect technique to improve transfer precision. A three-dimensional (3D) co-ordinate measuring machine determined that that addition-silicone (a-silicone) and polyether are superior materials for implant transfer procedures. Transfer caps "significantly reduced rotation in the XY-plane but did not improve the absolute 3D displacement," they concluded. The most precise transfer resulted from a-silicone with transfer caps while polyether and polyvinyl siloxane comparisons favored silicone. Further, they note that "absolutely precise fit may be unattainable owing to the physical properties of the materials," and suggest that future studies be undertaken "to evaluate the amount of tolerable stress at the implant-bone interface."

Wee et al have noted that die systems used for multi-implant casts are crucial for obtaining optimum intraoral fit in accord with painstaking prosthodontic procedures accompanying implants. The in vitro study compared "the accuracy of implant casts fabricated from three conceptually different die systems at the solid, sectioned, and repeated stages." They used a polyether impression material to make 30 direct transfer implant impressions of the master cast. They made 10 experimental implant casts for each of three die systems: double-pour (Pindex), plastic base (DVA), and die tray (KO Tray). Analysis of measurements led them to recommend a double-pour or plastic base die system when a multi-implant-retained prosthesis requires sectioned dies. In an earlier in vitro study, Wee concluded that, when compared to high addition silicone materials, the highest anti-rotational torque values were provided by medium-body polyether impression materials; in addition, these materials also demonstrated the highest cast accuracy when compared to polysulfide.

It has been shown that the pick-up type impression coping is the more accurate type of impression as errors occur on removal and replacement of the transfer type impression copings, especially in the occluso-gingival direction.[18]

However, there are indications to use of the transfer type impression coping. When there is limited mouth opening they can be used as there may not be sufficient space for access to the screws retaining pick up type impression copings with the impression in place and in patients with an exaggerated gag reflex, when the impression has to be removed as quickly as possible.[18]

Many articles have been written and many in vivo studies have been carried out to improve the fidelity of impressions over the use of pick up type impression copings alone. Some advocate connecting the impression copings together intra orally prior to impression making with acrylic resin. These studies indicate that there is not statistically significant improvement when splinting impression copings with acrylic, however, the deviation of these impressions from the standardized cast is smaller. Others advocate use of impression plaster to connect the impression copings. Manufacturers have developed impression copings with 'metal wings' that can be connected with acrylic resin to reduce the bulk of shrinking acrylic to further improve dimensional stability of the impression in order to obtain a passive framework. Yet others have advocated corrected impression techniques where impression copings are connected then with only one impression coping related to the cast the other analogues are retrofitted to the cast to compensate for distortions of the impression material and the distortions of the setting die master cast material. Other authors have demonstrated that none of the above procedures are likely to improve the fidelity of the impression over use of a rigid custom tray and pick up type impression copings with an elastomeric impression material.[18]

Chee et al. suggest to use an open custom tray which is rigid, to allow access to the retaining screws of pick up impression copings, to use a polyvinyl siloxane impression material with adhesive applied to the custom tray and poly ether as a soft tissue cast material.[18]

Mark Spector conducted a study which suggests that although the errors measured were relatively small, there was a potential for distortion with the transfer techniques used.[16]

In a study conducted by Balouch the obtained results indicated that closed tray impression method had lesser dimensional changes and it was more acceptable than open tray technique.[19]

Rismanchian and Moniri Fard concluded that direct impression (open tray) method was more accurate than indirect (closed tray) method.[19]

Seyyedan et al. did not distinguish a significant difference between open tray and closed tray techniques. Also, angulations of the implants were not mentioned in their research.[19]

Based on a research enrolled by Heather et al.; accuracies of two impression techniques, namely open tray and closed tray, were not significantly different.[19]

Galluci et al. suggested that closed-tray impression techniques had no statistically significant difference compared to open-tray techniques for the multiunit partially edentulous situation when implants have less than 10 degrees of angulation.[20]

The study of Daudi et al. investigated the accuracy of the two impression techniques for single implants in laboratory and focused on the accuracy of four impression processes of implants through direct and indirect methods; using poly ether and poly vinyl siloxane materials. The SAS software was utilized in their work which identified the indirect method as more preferable.[19]

Walker et al. worked on the accuracy of implant casting as a function of impression technique and viscosity of the impression material. They demonstrated that casts built through closed tray (indirect) method with metallic copings on the surface of the implant were more accurate than the casts fabricated by open tray (direct) method with plastic copings.[19]

Studies also show that cast accuracy was not affected by impression material viscosity, using a stiffer impression material around the impression coping or cap did not produce more accurate casts with either the closed tray indirect or direct technique. Cast accuracy was affected by the impression technique. The closed tray/indirect impression technique using screw-on metal impression copings at the implant level yielded more accurate casts than the closed tray/direct impression technique with plastic impression caps used at the abutment level.[21]

Ongul et al. conducted an in vitro study and concluded that for situations where impressions of multiple implants in edentulous arches must be made and the pick-up implant impression technique is used, splinting impression copings with acrylic resin provide better results than either non-splinted techniques or splinting using a light-curing composite.[22]

More recently, a development has been computer-aided design and computer aided manufacturing (CAD/CAM) to construct implant prosthesis. This technology utilizes 3D intraoral scanners. Digital implant impression technique has proven its possibilities as an effective alternative for the analogue impression-taking technique.[23]

Traditional vs. Digital Impression Techniques

Accurate impressions depend on proper technique and materials. Elastomeric impression materials (polyethers, polyvinyl siloxanes, and hybrids) are popular because of their excellent physical and mechanical properties, including precise detail reproduction, high elastic recovery, and dimensional stability. The decision to use one over the other varies among clinicians and is based upon personal preference. Although it is clear that elastomeric materials have improved over the years, their use continues to present some challenges. Traditional impression techniques involve multiple steps, making errors more prevalent both in the hands of clinicians and laboratory technicians. Patient comfort is also a concern due to tray fit, taste of material, and set time of the impression material. Consequently, digital impressions were introduced to overcome some of the obstacles seen with traditional impression materials and techniques. Clinical studies have also shown that indirect restorations fit more accurately when a digital impression is taken as opposed to a traditional impression. In digital impressions, intraoral scanners are used to create a digital image of the patient's teeth, eliminating the need for traditional impression materials, as well as increasing patient comfort and decreasing anxiety. Using either a laser or video, digital impressioning acquires an image with a digital scanning device that optically records the patient's dentition and bite relationship. Light is projected from the tip of the scanner, and a camera collects data, which are further manipulated to produce a digital model of the patient's dentition. Current systems use different light source technologies, including laser, structured (striped) light, or LED illumination. Some systems require the use of titanium dioxide powder as a contrast medium, whereas others do not. Data collection methods, strategies, and size of scanner head may vary between scanners, but each procedure culminates in a digital model of the patient's dentition.[24]

Although conventional impression materials like poly (vinyl siloxane) and polyether are well developed and present great accuracy in many prostheses, the intraoral digital impression technique has a distinct superiority in work efficiency and saving of materials. The further improvement of the intraoral digital impression technique will lead to its wide use in dentistry.[24]

CONCLUSION

For the longevity and success of an implant supported prostheses, an accurate impression for a precise working model is one of the pre-requisites. Each clinical situation demands a proper technique that would require minimal time and would be easy to perform, inexpensive, comfortable for the patient and give the best results.[2] This therefore calls for a thorough understanding of various contemporary impression materials and techniques for their better utilization in different clinical situations.

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