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Analog Implant Prosthetics Restoration using Conventional Impression Method

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ABSTRACT:
The accuracy of implant prosthetic restorations is a key determinant of long-term success, directly influencing functional and aesthetic outcomes. Conventional impression techniques, specifically those involving analog methods, remain a widely used method for recording precise implant positions despite advancements in digital technology. This systematic review aims to evaluate the effectiveness, precision, and clinical outcomes of analog impression techniques in implant prosthetics. A thorough examination of studies assessing variables such as impression materials, coping designs, implant angulation, and splinting methods was conducted. Additionally, the review highlights challenges associated with analog techniques, such as dimensional distortion, material shrinkage, and the lack of standardization in procedures.
Findings suggest that while traditional impression techniques, particularly the splinted open-tray method, demonstrate reliable accuracy, certain factors—such as coping selection and implant configuration—affect the overall precision. Despite ongoing efforts by manufacturers to standardize analog techniques, variability in clinical application persists. This review underscores the need for further innovation and consistency in conventional implant impression methodologies to ensure improved clinical outcomes.
Keywords: implant prosthetic restoration, analog impression, accuracy, splinted technique, systematic review

I. INTRODUCTION:

A precise impression is required for making an accuratemaster cast, which is necessary to fabricate restorations that fit properly.An inaccurateimpression could result in improperly fitting restorations, which could cause several mechanical problemsand biological problemssuch as occlusal errors, fractures of screws and implants, prosthetic screw loosening, and mucositis or peri-implantitiswhich can ultimately result in implant failure(1)(2).

To ensure the prolonged efficacy of osseointegrated implants in rehabilitating completely or partially edentulous patients, an accurate impression is essential(3). The lack of periodontal ligament support in intraosseous implants fails to reduce stresses associated with prosthetic restorations. (4-6).Precision in implant rehabilitation is probably a critical factor. Ensuring a passive fit for implant-supported prostheses helps evenly distribute the load, which in turn reduces mechanical problems like screw loosening or fractures (7,8,9).A restoration is said to have a passive fit if it fits without placing any static strain on the surrounding tissue or the prosthetic system(10).

Several clinical and laboratory factors can influence the fit of these prostheses. Accurately transferring the implant position and angulation from the patient to the functional model is essential(9,11,12). If this transfer is not done properly, it might create misalignment, resulting in an ill-fitting prosthesis or a prosthesis with no passive fit that puts unnecessary strain on the implants and surrounding tissues. This may jeopardize the longevity and success of the implant rehabilitation.

Numerous impression techniques and materials are advocatedin literature to accurately transfer the implant position to the laboratory for prosthesis fabrication. Each technique has its specific advantages and limitations, depending on the clinical situation, the type of implant, and the desired outcome of the prosthetic restoration. The selection of techniques and materials can greatly influence the precision and effectiveness of the resulting prosthesis(13).

The aim of this review is to identify the challenges associated with making an implant impression and to offer guidance on the appropriate materials and techniques for minimizing errors.

IMPRESSION MATERIALS USED:

Impressions can be made with a wide range of materials, such as hydrocolloids, elastomers, and impression plaster, for dental implants. The four primary types of elastomers are polysulfides, polyether, condensation silicones, and addition siliconecommonly known as polyvinyl siloxane. The area of prosthodontics saw a significant improvement in both impression accuracy and restoration quality with the development of elastomeric impression materials, which provided the benefits of dimensional stability and accuracy.Several in vitro and in vivo research are still being conducted in the development of impression materials(14).

It has been reported that implant impression coping impressions are made using a single-stage impression technique, typically involving a combination mixing and application of putty and light body elastomeric impression materials(15).The single-stage impression technique for implants involves recording the implant's position and surrounding soft tissue in a single clinical step, which increases efficiency and accuracy. It reduces treatment time and increases patient comfort, making it suited for stable soft tissue conditions(16).

The failure to include polysulfides and condensation silicones can be attributed to their inability to maintain their dimensions over time, whereas the evaporation of volatile byproducts generated during polymerization causes condensation silicones to shrink.

The qualities of polyether impression materials include hydrophilicity, tear resistance, stiffness, and dimensional stability. Because of the ether and carbonyl functional groups in their chemical structure, water molecules can interact by forming hydrogen bonds. They might expand though, if left close to moisture, which could affect their accuracy(17).

For excellent implant impressions, polyvinyl siloxane (PVS) provides a lot of the desirable features of polyether at a lesser cost. When implants are placed deeply subgingivally, PVS putty and light-body materials work better together to achieve precision than medium-body polyether(18). Implants positioned at a 0-degree angulation present a lower distortion risk than those angled at 15 or 30 degrees in the posterior region. Furthermore, silicone is considered the optimal material for angulated implants, while polyether is recommended for parallel implants(19).

A recently developed substance called vinyl siloxanether has outstanding wetting abilities in both its unset and set stages, as well as excellent mechanical and flow properties. After setting, it instantly acquires its maximum hardness and can react chemically with polyvinyl siloxane. However, further research needs to be done to properly establish the precision of this recently developed material(20).

Impression Material	Type	Characteristics	Advantages	Disadvantages
Polyvinyl Siloxane (PVS)	Addition Silicone	High dimensional stability, excellent detail reproduction, hydrophobic	High accuracy, tear-resistant, long shelf life	Hydrophobic, difficult to pour in stone
Polyether	Elastomeric	Stiff, hydrophilic, excellent flow properties and high dimensional stability	Accurate in moist conditions, good flow and wettability	Stiff, may cause difficulty in removing from undercuts
Condensation Silicone	Elastomeric	Less dimensionally stable than PVS, quicker setting times	Moderate accuracy, quick setting	Prone to shrinkage, lower stability over time

Polysulfide	Elastomeric	High tear strength, good flexibility, longer working time and high dimensional stability	Good for full arch impressions, high tear strength	Unpleasant odor, longer setting time, less stable

As a result, Polyvinyl siloxane and polyether are recommended as ideal materials due to their excellent resistance to positional distortion that can occur from the displacement of impression copings(18).

IMPLANT COMPONENTS REQUIRED FOR MAKING IMPRESSION:

IMPRESSION COPING:

Impression coping plays a crucial role in connecting to the head of an implant fixture or abutment during the impression-making process. The impression copings come in two types: one is specifically made for use with a closed tray and stays in the mouth after the impression has been taken. In contrast, the other is used with an open custom tray, where the coping is retained within the impression when removed (21).

IMPLANT ANALOG:

An implant analog, also known as an implant replica, is a laboratory tool that reproduces the dimensions and shape of a dental implant fixture. It is utilized in the production of prostheses, allowing the dental technician to work with a physical model that resembles the in-place implant.

Implant analogs are connected to impression coping before casting the impression. These replicas are integrated into the model, accurately reflecting the position andshape of implant fixture heads. It is essential for the clinician to carefully attach the implant analog, ensuring that the impression coping remains stable and does not rotate throughout the procedure(22).

ABUTMENT ANALOG:

Abutment analogshelpin selecting the correct standard abutment. When handling multiple implants, choosing standard abutments typically requires evaluating a model of the fixture head.

Analogs are employed to convey the implant's location within the patient's mouth through the creation of a mold using an impression post. They serve as precise reference points for the lab technician to accurately position and shape the abutments required for the fabrication of a crown or bridge for the implant. Choosing high-quality implant analogs is essential, as their design is specifically made to replicate the exact internal and external features of the final implant, along with its positioning within the patient's mouth(23).

ABUTMENT:

The abutment of a dental implant is connected to the to the implant body and is secured by being screwed into place. Its primary function is to hold the prosthesis firmly in position by functioning as the coronal support for the implant prosthesis. The abutment contains several parts the base, which fits into the implant'sinternal core; the head, which extends outward and serves as a retainer for the prosthesis; and the collar, located at the gum line, linking the base and head. Abutments can be designed as a single unit or as two separate components(24).

Different types of abutments: Standard abutments are generally cylindrical and are available in different heights, along with matching titanium abutment screws. The bottom portion of the standard abutment has a hexagonal design that securely fits into the implant fixture(25).Angulated Abutments possess an angled design, usually presenting an angulation of either 30 degrees or 17 degrees to meet particular clinical requirements (26).Estheticone Abutments are specifically designed for aesthetic prosthetic applications, including multiple implant screw-retained restorations, ceramic-metal restorations, and cast metal restorations. These restorations are typically placed 2-3 mm below the gingival margin, providing a natural and visually appealing outcome (27).

When the placement of the implant is ideal, the prosthetic superstructure can be directly attached to the fixture head using screws.

The Dynamic Universal Castable Long Abutment (UCLA) serves as an alternative solution for addressing implant tilting. This abutment allows for adjustments in the implant emergence profile by as much as 20°, thus enabling its repositioning into a more advantageous alignment(28).

The multi-unit abutment is designed specifically for the restoration of dental arches that are either completely or partially lacking teeth. It is especially appropriate for application within the clinically and scientifically supported All-on-4 treatment approach.(29,30)This abutment includes a short cone design for cases with limited interocclusal space, along with a wide shoulder that simplifies the positioning of the prosthetic restoration. To accommodate different soft tissue anatomies, multi-unit abutments are available in both straight and angled options (0°, 17°, 30°, and 45°), and they come in a variety of collar heights.(31)

SNAP-ON IMPRESSION CAP:

The implants had a snap-on impression cover and a plastic position cylinder. The impressioncaps can be snapped onto the implant shoulder with a noticeable click, and their position isconfirmed by gently rotating them. The impression caps had the plastic positioning cylinders inserted into them. After the impression material had fully set, the implant analogs were placed into the impression caps, and the positioning cylinders were firmly engaged with a click.

Variousstudies concluded that the snap-on technique demonstrated superior accuracy compared to other closed-tray impression techniques and was comparable to open-tray methods. The null hypothesis of no significant differences in impression procedures for dental implants was rejected. Multiple studies have investigated the accuracy of the snap-on technique.(32,33).

CONVENTIONAL IMPRESSION TECHNIQUES:

Conventional Impression Techniques for Analog Implant Prosthetics refer to standardized methods used to create accurate replicas of the oral environment, specifically for dental implants, to facilitate the fabrication of prosthetic restorations. These techniques are performed to capture the spatial relationships and positions of implants within the jaw.

- Direct Impression Technique (Open Tray Impression Technique)
- Indirect Impression Technique (Closed Tray or Transfer Impression Technique)

By Impression Level:

a. Fixture-Level Implant Impression
b. Abutment-Level Implant Impression

Direct Impression Technique (Open Tray Impression Technique):

The impression coping is directly attached to the implant fixturewithin the oral cavity (Figure .1). Custom trays with open occlusal surfaces are meticulously designed to provide an exit for the abutment screw through the opening(Figure .2). During this procedure, the implant is positioned in a hexagonal configuration(Figure.3) and the transfer coping and abutment screw are secured into the implant body, and the impression is made using a polyvinyl siloxane material in custom tray (Figure.4).After the impression material has been set, the screw is removed from the open tray. The entire impression is then carefully removed as a single unit, leaving the coping securely in place (Figure .5).This open tray technique reduces the impact of implant angulation and deformation of the impression material during removal, eliminating the need for precise adjustments of the copings within the impression(34).

This method is further categorized into splinted and non-splinted techniques.

The objective of splinting impression copings is to connect them with a rigid material, enhancing stability and ensuring accurate alignment during the impression-taking process, It ensures that none of the individual copings shift during the impression-taking procedure(35).The splinted direct impression technique involves securing the impression posts together before taking the impression. This methodimproves accuracy and helps prevent distortion during the position of the implant analog with the corresponding impression post(36,37).A variety of materials are commonly utilized for splinting impression copings, including light-cured composite resin, impression plaster, orthodontic wire, acrylic resin, thermoforming material, and auto-polymerized acrylic resin, often used with dental floss as a scaffold[38,39].A new method for splinting implants incorporates the use of titanium bars that are welded directly to the abutments or impression analogs within the mouth.

Figure 1. OPEN TRAY TRANSFER COPING, IMPLANT ANALOG

Figure 2. CUSTOM TRAY FOR IMPRESSION WITH OPEN TRAY TECHNIQUE

Figure 3. OPEN TRAY TRANSFER COPING (INTRAORAL)

Figure 4. CUSTOM TRAY WITH OPEN TRAY TRANSFER COPING

Figure 5. OPEN TRAY TRANSFER IMPRESSION WITH IMPLANT ANALOG

INDICATIONS :
The open tray technique is especially advantageous in several clinical situations.
1. It is indicated for non-parallel implants, where alignment challenges may arise due to differing angles of the implant fixtures.
2. It is essential for screw-retained restorations, ensuring stability and accuracy during the impression process.
3. It is recommended for multiple-unit restorations, as it helps maintain the spatial relationship between adjacent implants.
4. It is used when taking full fixed arch mandibular impressions, as it enhances the overall rigidity and reliability of the impression, contributing to the precision of the final prosthetic outcome.

Indirect Impression Technique (Closed Tray or Transfer Impression Technique):

The closed tray technique requires the insertion of a tapered impression postinto the implant during the impression-taking process(Figure .6). Initially,the healing screw is removed, and transfer coping is secured (Figure .7). A radiograph is subsequently taken to verify the secure and accurate connection between the impression post and the implant. To prevent impression material from entering the screw hole, it is advisable to seal it with wax. Once the impression is completed, the material is allowed to set before the impression is carefully removed from the patient's mouth, ensuring that the transfer coping remains intact(Figure .8). The post is then unscrewed and attached to the implant analog for further processing which is known as the transfer process.Finally, ensure the impression post and analog are properly positioned (40).

Figure 6. IMPLANT ANALOG AND CLOSED TRAY TRANSFER COPING

Figure 7.CLOSED TRAY TRANSFER COPINGS (INTRAORAL)

Figure 8. CLOSED TRAY TRANSFER IMPRESSION WITH IMPLANT ANALOGS

INDICATIONS:

The closed tray impression technique is indicated in several clinical scenarios where its advantages can be effectively utilized

1.It is particularly suitable for cases involving parallel levels of fixture insertions, ensuring accurate transfer of implant positions

2. This technique is also beneficial for single-tooth cemented restorations, as it provides a reliable impression for proper alignment and fit.

3. it facilitates the fabrication of provisional restorations by capturing precise implant positions.

4.is advantageous for patients with limited inter-arch space, minimizing discomfort and bulk during the impression-taking process.

5. It is also ideal for individuals with a tendency to gag, as it reduces the duration of impression sessions. Furthermore, this technique is valuable in situations where the mouth opening is restricted, allowing for an efficient impression process without excessive manipulation.

Fixture level impressions:

The impression coping is secured to the implant fixture. After obtaining a fixture-level impression, the abutment can be selected directly on the model while fabricating the superstructure. Screw-retained abutments are attached to the models before the development of the superstructure.

Abutment level impressions:

To obtain an abutment-level impression, the abutments are securedto the implant fixture and this is followed by attaching the impression copings. This method ensures that the abutment remains in place during the impression-taking process. To prevent gingival overgrowth and maintain accuracy, a provisional restoration should be placed over the connecting abutment until the superstructure is fully constructed(41).

II. DISCUSSION :

Accurate impression-making is essential in fixed prosthodontic treatments for capturing dental morphology and ensuring proper oral restoration. Neglecting this critical step can result in an inaccurate impression and poor prosthesis adaptation. Inaccuracies in the impression process may lead to expensive and time-consuming retakes for patients. Therefore, it is essential to use the most accurate impression techniques to ensure optimal treatment results (42,43). The accuracy of the model plays a key role in ensuring compatibility with implant-supported fixed and removable prostheses. Consequently, factors such as the choice of impression material, technique, type of tray and the decision to use splinting must be carefully evaluated.Although stock trays can produce accurate impressions, they are often less consistent than custom trays. However, with the right impression materials and techniques, a rigid stock tray can be a viable alternative to custom trays for obtaining implant fixture-level impressions(44).Polyether and polyvinylsiloxane are commonly used impression materials for implant restorations due to their dimensional stability, resistance to deformation, and rigidity. However, evidence supporting the superiority of one over the other remains limited (4, 45).Reconstructing the intraoral implant position during the impression process is critical for fabricating accurate prostheses that allow tension-free insertion and contribute to treatment success (46). Research suggests that implant impressions should be made using polyether or additional silicone materials. Sorrentino et al. found that the use of silicone resulted in more accurate outcomes compared to polyether for non-parallel implants(47). Similarly, Hatim and Al-Mashaiky found that using a two-stage addition silicone technique (combining light and heavy body materials) yielded more precise die-stone models and improved treatment success.Al-Mashaiky and Hatim observed that cast produced using a two-step impressionmethod are more accurate than those made with a one-step method, especially when additional silicone is used as the impression material (48). Casts created using a single-step indirect impression technique exhibited significant dimensional changes. Research indicates that the two-step direct impression technique is the most accurate method for transferring implant positions from the patient's mouth to the laboratory cast. Additionally, the putty-wash two-step impression technique yields more precise casts compared to the one-step technique.

To produce a definitive cast for an implant using direct or indirect impression techniques, impression copings and replicas are essential. The accuracy of the final cast is affected by the degree of movement between the replicas and the impression copings(49,50). More studies in cases involving four or more implants demonstrated that accurate impressions were obtained using the open technique. Half of the studies supported the open method as the most accurate approach for achieving impressions with three or fewer implants. Furthermore, one study found no significant difference in accuracy between the two methods.One study found that snap-fit plastic impression copings and metal copings exhibited comparable accuracy. However, the study also emphasized that the engagement of the impression cap with the implant shoulder can fracture or deform, potentially compromising its reliability.(51)

Several strategies have been proposed to enhance impression accuracy. Among these, the splinted technique is extensively reported in the literature and is considered the most accurate, despite some variation in viewpoints (52).The process involves securing all impression copings with acrylic resin to prevent individual movement and ensure rotational stability throughout the impression procedure. This method also facilitates the transfer of not only the copings but also their splinted connections to the impression material (53).However, the authors noted potential challenges with the splinted technique, including the risk of breakage at the junction between the splinting material and the impression copings, particularly as a result of the contraction of the splint material (54).

The impression stage is critical for achieving implant accuracy due to the lack of standardization and the need for dentists to account for various factors, such as coping design, implant angulation, and the choice of impression material. A dentist’s evaluation of a patient’s unique characteristics—such as bone density, arch asymmetry, and surface morphology—is essential in selecting the appropriate tools and impression materials to ensure optimal treatment outcomes. As technological advancement provides more digital solutions research will be directed towardsoptical impressionalthough manufacturers strive to standardizeconventional and digital impression techniques, there remains a notable gap in innovative and consistent procedures. Ultimately, the responsibility lies with the clinician to adapt their approach to each individual case.

III. CONCLUSION :

In conclusion, analog implant prosthetic restoration using conventional impression methods remains a reliable and widely used approach in clinical practice. Despite advances in digital techniques, conventional methods offer precision when executed with careful attention to factors such as impression material selection, coping design,implant angulation and most efficiently cost-effective. The splinted impression technique, in particular, has been shown to improve accuracy in cases involving multiple implants, though potential challenges, such as material shrinkage and connection failures, should be considered. While the field progresses toward standardization, the success of conventional impressions ultimately relies on the clinician's ability to customize techniques to each patient's unique anatomical and procedural requirements. Further research is needed to refine these techniques and address existing limitations to enhance consistency and accuracy in implant restorations.

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