ABSTRACT

Introduction: Implantology is the fastest growing specialty in dentistry. A key point for the accurate fabrication of fixed prosthetic structures is taking an accurate impression of the prosthetic field. The implant-prosthetic restoration of the masticatory apparatus after the composition of the function and aesthetics of the dentition through digital technology is gaining wider popularity.

Aim: The purpose of this article is to address impression materials and compare the two methods of impression taking from implants—conventional and digital—and clarify their advantages and disadvantages.

Materials and Methods: After reviewing materials, studies, and publications on the subject, we tried to present and systematize the main methods and techniques for taking an impression of implants in a conventional and digital way, as well as their advantages and disadvantages. The search was conducted using various keywords and combinations: “transfer impression”, “conventional impression”, “intraoral scanner”, “CAD/CAM”, “scan body”.

Results: Forty-one original and review articles were reviewed. Impression materials, impression-taking techniques in permanent implant prosthodontics by conventional and digital methods, and types of intraoral scanning systems are discussed.

Conclusion: Taking an accurate impression is a key point in implantology. There are differences in the impression taking techniques of implants. Two main impression techniques are used, direct with an open tray and indirect with a closed tray. According to many literature sources, the open-tray impression technique is more precise and produces more accurate results, while others believe that the closed-tray technique is more accurate. More and more often, conventional impressions are being replaced by digital ones. Digital impressions entered dentistry and, in particular, implantology as an alternative to conventional ones for the restoration of small defects such as single crowns and short bridges.

Keywords: transfer impression, conventional impression, intraoral scanner, CAD/CAM, scan body
by providing retention and support of a fixed or removable prosthetic construction (1).

Implantology is the fastest growing specialty in dentistry. Implant-prosthetic restoration of the chewing apparatus after damage to the function and aesthetics of the dentition using digital technology is gaining wider popularity.

A key point for the exact fabrication of permanent prosthetic structures is taking an accurate impression of the prosthetic field. It can be taken conventionally as well as digitally (2). Based on the terminological dictionary, an impression is a negative likeness or copy of the surface of an object, teeth, or adjacent structures, i.e., in the prosthetic field (Glossary of Prosthodontic Terms Committee of the Academy of Prosthodontics), while the digital impression is not, i.e., it represents a positive copy of the prosthetic field.

The classification of impression materials is known, of which the group of elastomeric impression materials, namely, condensation silicones (C-silicones), additive silicones (A-silicones) based on polyvinylsiloxane, and polyethers are the most commonly used in permanent prosthetics. Silicone is a material that is widely used in dental practice. It shows qualities such as good resistance to permanent deformation, high final hardness, great linear and volume stability, small volume changes. A-silicones provide great accuracy when printing the details of the prosthetic field in the range of 1–2 μm (3). Good drying is recommended when taking the impression.

By nature, silicones are hydrophobic, but after 1986 additive silicones with improved hydrophilic properties began to be developed. Surfactants are added that improve wetting with the printed surface, reduce their surface tension, and thus improve the qualities of the material, bringing their hydrophilicity closer to that of polyether impression materials (4,5).

Polyethers are hydrophilic impression materials that have good stability and low permanent deformation. This also allows for multiple castings if necessary (6). The handling time of polyethers is longer than that of silicones, that is, they remain in an elastic/plastic state longer. The modulus of elasticity (hardness) of polyethers is greater than that of silicones, which can make it difficult to remove the impression from the oral cavity (4,7). Despite their inherent hydrophilicity, it is also recommended to dry the prosthetic field when taking an impression. Because of this quality of polyethers, liquid imbibition is possible during disinfection procedures and therefore storage in disinfectants for more than 10 minutes is not recommended (8).

In dental implantology, the latter two impression materials are used (9,10). The accuracy of the impression depends on many factors, such as the type of material, the impression technique, the impression tray, the dryness of the prosthetic field, the human factor. Other factors, such as change in temperature, duration of mixing time, and disinfection procedures, could also have a negative effect on accuracy. In implantology, in addition to the above, the angulation of the implants and, if there are more of them, the splinting of the transfers are also important (11,12). Possible laboratory errors, such as casting of the working model, subsequent stages in the fabrication of the structures, such as casting, pressing, are key to the success of prosthetic treatment with fixed structures (2,10).

**IMPRESSION TECHNIQUES IN IMPLANTOLOGY**

There are differences in the technique for taking an impression of implants depending on the material used and the type of impression tray used (10). Impression trays can be standard and open. The latter, on the other hand, can be plastic, which can be cut, assembled or individually made with holes in the area of the implants. Two main impression techniques are used, direct with an open tray and indirect with a closed tray. According to many literature sources, the open tray impression technique is more precise and produces more accurate results (13,14,15), while others believe that the closed-tray technique is more accurate (16,17). An accurate impression is required to correctly recreate the optimal location of the implants so that the final restorations are accurate. Mismatches between the prosthetic structure and the osseointegrated implants can lead to internal stresses and create an excessive load on them (10,17). This can lead to bone loss and even affect osseointegration, which can impair healing. For this purpose, it is necessary that sufficient time has passed since the placement of the gingivoformer, especially if the implants are in the frontal area.
One of the requirements for taking an accurate impression is that the mucosa is healthy and does not bleed, i.e., a healthy and well-formed gingival cuff is present. Particular attention should be paid when the implants are angulated (13,14,15).

**Advantages of an open tray impression:**
- An open tray impression is more suitable in cases with angulation, as it can be compensated to a certain extent.
- Another advantage is that the degree of deformation of the impression material is reduced.
- The technique is easy to perform.

**Disadvantages of open tray impression:**
- The need for more clinical time to adjust the tray.
- Possible movement of the transfers during the impression taking, which can lead to inaccuracy in transferring the proportions of the implants in the laboratory stage when casting a working model.
- Care should be taken to expose the retention screw through the occlusal opening for easier location and loosening after the material is elasticized.

With more implants, in order to avoid rotations of the transfers, some clinicians recommend splinting them, which on the one hand takes more clinical time, but on the other hand leads to more accurate results (14,18,19,20).

When taking an impression with a closed tray, additional impression components such as plastic caps are used, which remain in the impression. It works with standard metal or plastic trays.

**Advantages of closed tray impression:**
- with limited space between the dental arches or inability to open the mouth wide;
- when the implants are in the distal area of the dentition and there is not enough space to place the long transfers;
- with a strong nausea reflex.

**Disadvantages of closed tray impression:**
- deformations can be created in the impression when the implants are not parallel;
- difficulties with deeper implants (19, 21);

Most authors recommend the use of a rigid open individual tray, which allows access to the impression screws, coated with adhesive and polyvinylsiloxane as an impression material.

**CAD/CAM**

Working with conventional printing techniques dates back to 1900. With the introduction of new materials in dentistry and dental technology, new techniques are also introduced. The introduction of technologies such as computer aided design/computer aided manufacturing (CAD/CAM) began as early as 1980, and later technologies such as 3D printing also entered the field. This marked a new chapter in the development of modern dentistry, namely digital dentistry. This allowed the introduction of new materials, optimization of the work process, both for the dentist and in the dental laboratory. Last but not least, patient comfort was improved and the number of visits was reduced. CAD/CAM technology has revolutionized the manufacturing of implant-supported and natural tooth-supported fixed prosthetic structures through digital design in software and subsequent computer-aided fabrication through milling or 3D printing without the need to cast a physical model (22,23).

More and more often, conventional prints are being replaced by digital ones. Companies on the market offer various software applications, as well as constantly develop and update technical devices, so that the team of dentists and dental technicians can choose for themselves from which stage of treatment to proceed with a digital protocol or to keep one of the steps in the conventional approach and apply the best of both techniques, i.e., a partially digitized protocol.

The CAD/CAM system consists of three elements: data acquisition device, software, and production unit. The necessary units for a digital work protocol are an intraoral scanner, with which to scan and transfer the data to software, where they can be processed and create a model of the future structure, as well as a production unit—a milling machine or a 3D printer. Depending on whether you are adding or removing material, the technology is additive or subtractive. Intraoral scanners are devices that collect a large amount of information from the prosthetic field by taking many images and...
transferring and processing this data in a software. Until the scientific developments that began in the 1970s, this technology was only a hypothesis, and, in 1983, Dr. Francois Duret, who is considered to be the father of modern digital dentistry, was able to create a single crown using CAD software. From the introduction of this innovative technology to the present day, a number of companies have constantly been improving the principle of operation and the design of the devices themselves, which will improve the quality of work and the comfort of patients (24,25,26).

INTRAORAL SCANNING SYSTEMS

A wide variety of modern intraoral scanners is available on the market. They work on the principle of active or passive triangulation, confocal microscopy, etc. Regardless of the scanning principle of the different generations of systems, the technology is based on non-contact collection of information from the prosthetic field and its transfer to software. Examples of scanners that work on the principle of active triangulation are CEREC Omnicam (Dentsply Sirona) and FastScan (IOS Technologies), iTero (Cadent)—TRIOS (3Shape)—works on the principle of confocal microscopy and E4D (D4D Technologies)—optical coherence tomography (27,28).

There are different systems with open, semi-open, or closed architecture depending on the type of file that is created during scanning. The first two provide a greater degree of freedom to the clinician and connection to different dental laboratories when exporting the data, as they are saved in an STL format (29,30,31).

DIGITAL IMPRESSION IN IMPLANTOLOGY

Digital impressions entered dentistry and, in particular, implantology as an alternative to conventional ones for the restoration of small defects, such as single crowns and short bridges (32).

Taking an accurate impression is a key moment in implantology. Improperly transferred implant position to the dental laboratory would in turn lead to inaccurate prosthetic construction and later biological and mechanical complications. In cases with implant prosthetic constructions, inaccuracies in the restoration would generate stress on the implants and the bone itself. Such inaccuracies, such as incorrect fit of the structure on the abutments, can lead to screw loosening or its breakage (late prosthetic complications) (33).

Fabrication of constructs on implants can be done by a direct full or partially digitized protocol. The full digital protocol consists of determining the position of the implant by taking a digital impression with an intraoral scanner and intraoral scan bodies directly from the patient’s mouth. A scan body is positioned on each implant to transfer the three-dimensional position of the implant relative to the x-, y-, z-coordinate axis to the CAD software via an STL file. This is followed by transfer and processing of the data in the CAD software and positioning of the implant analog in the digital 3D model. After the construction is completed in the software, the file is transferred to the manufacturing unit (CAM), depending on the restorative material, subtractive or additive technologies (with removal and addition of material) can be used (34).

The creation of a structure with the partially digitized protocol is related to the availability of a laboratory scanner with the help of which a model is scanned from a conventionally taken impression, and the scanned bodies can be used again. Then, in special software equipped with libraries for the purpose, the implant analog is positioned in the 3D model. The design is completed in the software and transferred back to the production unit.

There are different types of scan bodies on the market, they are usually cylindrical in shape, with or without a taper, and this does not affect the emergence profile that must be recreated with the construction. In addition to their geometry, they differ in material, surface, connection, compatibility with software. Scan bodysuits consist of three components: base, body, and scanning top. Intraoral scan bodies differ in size from laboratory ones according to the limited space in the oral cavity and the difficulty of scanning, especially in the distal areas of the dentition (35). Usually, the uppermost scanning component and the body are made of the same material (titanium alloy, polyetheretherketone, resins, etc.), but have a different shape. In the area of the base, the connection to the implant takes place and is usually made of a different
material. A misfit or inconsistencies in this region as a result of, for example, material wear would be fatal to accurately recreating the implant position. The correct positioning of the scan body can be checked on an X-ray (36).

Advantages and disadvantages of digital impressions:

Some of the advantages of digital impression taking are reduction of impression deformation, improved visualization of abutments, reduced impression time, and good patient response. One of the biggest advantages is the visualization of the ‘positive model’ on a monitor in real time during the scan, whereas with the conventional technique the most important details are only visible after a working model is cast. If necessary, the scan can be resumed at any stage, which, moreover, can be selective only in a certain area of the dentition, where there is an inaccurate created, for example, as a result of bleeding and poor dryness of the prosthetic field. It is easy to analyze the supports and what space is available next to the antagonists. Some systems offer the possibility to capture dynamic articulation. In addition to the above, digital impression taking is a good method of communication with the patient, as there is no aging of the material as with the conventional technique and virtual models can be stored easily. Some scanning systems recreate a color model rather than a monochromatic one, they recreate the tooth and gingival texture, and in some systems the possibility of determining color is also included. In addition to everything described, an important factor is the saving of time by the experienced operator (29,37,38).

Disadvantages of digital impressions:

- In addition to the large investment for the purchase of an intraoral scanner are associated with the difficult handling of the scanner handle and the need for training to take a digital impression (29).
- The scanning of subgingival thresholds and the need for very good retraction is difficult (29).
- There is difficulty in scanning the proximal surface of an adjacent tooth if the interproximal space is limited, in such situations the use of intraoral scan bodies with a smaller diameter is recommended (39).

When scanning implants, it is necessary to accurately recreate their position, and for this purpose, scan bodies compatible with the relevant implantology system and the software itself are used (39).

DISCUSSION

A widely discussed topic in the current literature is the comparison of time to take a conventional and digital impression. Some authors investigated how patients with an increased nausea and anxiety reflex evaluated working with an intraoral scanner and found that they considered the technique more comfortable than the conventional one. They also collect data from dentists, most of whom prefer using an intraoral scanner without the need to cover the prosthetic field with dust before scanning. According to other sources, there was no noticeable difference in the accuracy of fabrication of the structures between the two methods, but patients felt more satisfied with the digital method. Last but not least, patients highly appreciate the predictability of treatment and the ability to view and evaluate future recoveries (40).

CONCLUSION

Digitization is advocated throughout the construction process from taking a digital impression, through planning in software to manufacturing using CAD/CAM systems through subtractive or additive method. The main advantages of these technologies and the purpose of their intensive development are to avoid errors in conventional methods of work, predictability of results even when planning the structures, improve their quality, and save clinical time.

REFERENCES


