

# Comparative analysis of patient perception and efficiency in dental impression techniques for posterior implant restorations

## Analiza porównawcza percepcji pacjentów i skuteczności technik wyciskowych zębów w przypadku odbudowy na implantach w odcinku bocznym

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### KEY WORDS:

patient comfort, dental impressions, prosthetic restorations, open tray technique, intra-oral scanning

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### HASŁA INDEKSOWE:

komfort pacjenta, wyciski dentystyczne, odbudowy protetyczne, technika otwarta, skanowanie wewnętrzne

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### Summary

**Introduction.** Traditional implant impressions, using physical materials, are evolving with intra-oral scanning technology. Optical impressions eliminate discomfort, offering precision and detail for clinicians, marking a paradigm shift in dental impressions.

**Aim of the study.** The primary aim of this clinical investigation was to gauge patients' perceptions regarding the distinctions between two dental impression techniques (intra-oral scanning) and conventional methods (open tray technique) when applied to posterior implant restorations. The secondary objective was to analyse the time differences related to the implementation of these two procedures.

**Material and methods.** Twenty patients (10 males, 10 females) without previous experience of conventional or digital impression taking participated in this study. They received 20 implants (Neodont bone level) in the non-aesthetic zone in the dental department of Farhat Hached Hospital in Sousse-Tunisia. Traditional pick-up impressions or open tray impression were taken

### Streszczenie

**Wstęp.** Tradycyjne wyciski do prac opartych na implantach, wykorzystujące materiały fizyczne, ewoluują wraz z technologią skanowania wewnętrznego. Wyciski optyczne eliminują dyskomfort, oferując lekarzom precyzję i szczegółowość, wyznaczając zmianę paradygmatu w zakresie wycisków dentystycznych

**Cel pracy.** Głównym celem tego badania klinicznego była ocena opinii pacjentów na temat różnic pomiędzy dwiema technikami wycisków dentystycznych (skanowanie wewnętrzne) i metodami konwencjonalnymi (technika otwartej łyżki) w przypadku stosowania uzupełnień na implantach w odcinku bocznym. Celem drugorzędym była analiza różnic czasowych związanych z realizacją tych dwóch procedur.

**Materiał i metody.** W badaniu wzięło udział dwudziestu pacjentów (10 mężczyzn, 10 kobiet), którzy przedtem nie doświadczyli ani konwencjonalnego ani cyfrowego pobierania wycisków. Wszczepiono im 20 implantów w strefie nieestetycznej na oddziale stomatologicznym szpitala Farhat Hached w Sousse-Tunezja. Tradycyjne

using polyvinylsiloxane impression material. After two weeks, a digital impression was taken using an intra-oral scanner. Immediately after the impressions had been taken, the patients' attitudes, preferences and perceptions of the implant impression technique were assessed using a standardized questionnaire with a visual analogue scale. The time required to complete these two procedures was also recorded (in seconds). Statistical analyses were performed with SPSS 21, and  $p < 0.05$  was considered significant.

**Results.** There were significant differences among the groups ( $p < 0.05$ ) in terms of total working time and processing steps. The patients stated that digital impressions were more comfortable than conventional techniques.

**Conclusions.** Digital impressions resulted in a more time-efficient technique than conventional impressions. Patients preferred the digital impression technique rather than conventional techniques.

wyciski typu pick-up lub wyciski typu Open Tray były wykonywane przy użyciu masy wyciskowej z poliwinylsiloksanu. Po dwóch tygodniach został pobrany wycisk cyfrowy za pomocą skanera wewnątrzustnego. Natychmiast po pobraniu wycisków oceniano nastawienie pacjentów, preferencje i postrzeganie techniki wycisku za pomocą standaryzowanego kwestionariusza z wizualną skalą analogową. Czas potrzebny na wykonanie tych dwóch procedur również rejestrowano w sekundach. Analizy statystyczne przeprowadzono za pomocą SPSS 21, a  $p < 0,05$  uznano za istotne.

**Wyniki.** Stwierdzono istotne różnice pomiędzy grupami ( $p < 0,05$ ) pod względem całkowitego czasu pracy i etapów procedury. Pacjenci twierdzili, że wyciski cyfrowe były wygodniejsze niż techniki konwencjonalne.

**Wnioski.** Wyciski cyfrowe pozwoliły na uzyskanie bardziej efektywnej czasowo techniki niż wyciski konwencjonalne. Pacjenci woleli technikę wycisków cyfrowych niż techniki konwencjonalne.

## Introduction

In order for implant-supported restorations to be successful, it is crucial that the information regarding both hard and soft tissue is accurately communicated to the laboratory. The key factor in achieving this is to capture the three-dimensional positioning of the implant in its intra-oral state, rather than merely reproducing surface details to facilitate effective prosthodontic treatment. However, the impression techniques that can precisely record the placement of implants have become increasingly intricate and demanding. Numerous techniques have been proposed to produce a master cast that guarantees a secure fit of the prosthesis onto the implants. In implant dentistry, there are two classic methods for taking impressions: the closed and open tray techniques. According to a recent systematic review, the open tray technique for impressions

is more precise than the closed tray technique. Additionally, research has indicated that the pickup type impression coping is the most accurate method for taking impressions, as errors tend to occur when replacing the transfer type impression.<sup>1,2</sup>

Dental treatment is moving to digital technology. A major innovation is computer-aided design and computer-aided manufacturing (CAD-CAM), which have grown in popularity among dental practitioners over the past 25 years. The development strategy of CAD/CAM technology includes the automation of the production process and the optimization of the restoration quality through the use of new biocompatible materials, especially high-performance ceramics such as zirconia and lithium disilicate. Several studies have demonstrated the potential for precise restoration using CAD/CAM technology.

The exactitude of impressions depends on the material itself, the type of impression tray and the impression technique. Each step in the process introduces the potential for individual and/or material error. Impressions and resulting master impressions can vary depending on the practitioner's technique and materials.<sup>3</sup>

Digital impression and scanning systems were introduced to dentistry in the mid-1980s. It is predicted that within the next ten years, most dentists in the US and Europe will use digital scanners for taking dental impressions.

Digital impressions offer speed, efficiency, indefinite storage of captured information, and the ability to transfer digital images between dental offices and laboratories. Advantages of digital impression and scanning systems include improved patient acceptance, reduced distortion of impression material, 3D pre-visualization of tooth preparations, and potential cost and time efficiencies. A recent report by Lee & Gallucci compared surgeons' preferences for digital and traditional implant impression techniques. Several studies have been published on the accuracy of intra-oral scanners and digital impressions, testing single tooth restorations, consecutive multiple teeth, quadrant and full arch scans.<sup>4,5</sup>

The purpose of this clinical study was to evaluate the efficacy, clinical outcomes, and patient preferences and attitudes of digital impression technology versus conventional (pick up technique) impression in posterior implant restorations.

## Methods

### *Study design & patient selection*

A controlled clinical study was designed. The study population consisted of patients (10 males, 10 females), who were new to conventional or digital impression taking, participated in this study. They received twenty implants (Neodent bone level) in the non-aesthetic zone, treated

in the dental department of Farhat Hached Hospital, Sousse, Tunisia. Conventional pick-up impressions were made with polyvinylsiloxane impression material. After two weeks, a digital impression was taken using an intra-oral scanner (Medit i 700).

The subjects were informed in detail about the possible risks and benefits, and all signed an informed consent form. The study was performed following the principles outlined in the Declaration of Helsinki on experimentation involving human subjects.

The study protocol was reviewed and approved by the Ethical Committee of Tunisia of the university hospital of Farhat Hached of Sousse.

### *Inclusion/exclusion criteria*

After an initial examination, 20 patients (10 females, 10 males, aged  $31.87 \pm 2.76$  years), who fulfilled the following inclusion criteria, were recruited: no experience with traditional or digital impressions, good general health, good oral hygiene, no periodontal disease, and good mental health. They received implants (Neodent bone level) in the non-aesthetic zone (Tab. 1).

Prerequisites excluded from the study were previous experience with impressions, fixed or removable prosthetic restorations, multiple implants or implants in the aesthetic area, orthodontic treatment and preventive appliances.

### *Conventional impressions "Open tray impression procedure"*

One operator (H.B) selected the proper tray for both arches of the subject. The tray was perforated in the regions where implants were placed to provide access for the pick-up copings. Then the healing screws were removed and the square impression copings were placed into the implants.

Retro-alveolar X-rays were taken along the long axis of the implant to ensure that the

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
In need of an implant in the posterior zone	In need of an implant in the aesthetic area
Single implant	Multiple implants
No previous experience with impressions	Previous experience with impressions
Older than 21 years of age	In orthodontic treatment
Good general and mental health	With fixed or removable prosthetic restorations
Acceptable oral hygiene	Less than 20 years old
Informed consent obtained	Non-compliance by the patient

impression copings were seated completely into the hex of the implants.

The pick up impression was taken with polyvinylsiloxane impression material (heavy and light consistency) using the 1-step impression technique. All materials were used according to the manufacturers' guidelines and performed by the same operator (H.B). The effectiveness and clinical outcomes of the conventional impression technique were evaluated by measuring the total treatment time, including the individual steps (tray selection, adhesive application, upper/lower impression and bite registration).

The treatment time was measured in seconds and recorded for each step by a second operator (Z.H) Immediately after the impressions had been taken, the attitudes and perceptions of the subjects towards the conventional impression technique were evaluated using a standardized questionnaire.

#### *Digital impressions*

A digital impression appointment was scheduled for the same patients 2-3 weeks following the conventional impressions procedure. The digital impressions were performed with the chairside dental CAD-CAM system (Medit i 700).

The digital impression electronic data constituents of the virtual models for both

arches and bite registration were recorded. All digital scanning procedures were carried out according to the manufacturer's guidelines and performed by the same operator (H.B). The effectiveness and clinical outcomes of the digital impression technique were evaluated by measuring the total treatment time, including the individual steps:

- 1 – entering patient's personal data (including name, last name, date of birth),
- 2 – laboratory prescription (including shade of restoration, material choice of restoration, form of restoration),
- 3 – upper and lower scan,
- 4 – scan with scan body,
- 5 – bite scan.

Treatment time was measured in seconds and recorded for each step by the second operator (Z.H). Immediately after the impressions had been taken, the attitudes and perceptions of the subjects towards the digital impression technique were evaluated with a self-administrated questionnaire using a Visual Analog Scale (VAS) ranging from 0 to 100.

The participants were also asked to answer a comparative questionnaire including the following research questions:

When it comes to impression procedures, which technique do you prefer when taking impressions for the second time?

When considering two different impression procedures, the question arises: which technique creates a more comfortable experience for you?

When it comes to the process of impression taking, which technique do you find preferable in terms of the amount of time it takes to complete the procedure?

During the impression process, which method of sensation do you favour: the sense of taste and smell or the sensation of heat and sound?

Which technique do you favour based on the size of the intra-oral scanner or impression tray used?

Which technique do you prefer specifically for patients who experience sensitivity in their gums or teeth during the process?

When it comes to the issue of experiencing breathing discomfort during the process of taking an impression, which approach do you find preferable?

When it comes to impression procedures, which technique do you prefer to be used in order to avoid triggering the gag reflex?

#### *Reliability and validity of questionnaires*

The questionnaires used in this study were pre-tested, revised, and retested before use.

#### *Statistical analysis*

Statistical analyses were performed with SPSS 21, with  $p = 0.05$  as the level for statistical significance, was performed to evaluate the differences in effectiveness and clinical outcomes between conventional and digital impression techniques. The attitudes and perceptions of the subjects on both impression techniques were assessed with a self-administrated questionnaire using a Visual Analog Scale (VAS).

#### **Results**

The assessment of effectiveness and clinical outcomes for both impression techniques is detailed in Table 2. For the open tray impression technique, the mean overall treatment time was  $1373.38 \pm 29.55$  s. The individual steps of the conventional impression technique exhibited the following mean times: tray selection,  $120 \pm 2.5$  s; tray perforation,  $208.69 \pm 3.14$  s; and adhesive application,  $27.58 \pm 7.5$  s. Additionally, the mean conventional impression times for the upper and lower jaws were  $896.66 \pm 21.52$  s, and the mean bite registration time was  $120.45 \pm 10.84$  s.

Concerning digital implant impressions, the mean overall treatment time for the digital impression technique was  $656.51 \pm 29.11$  s. The

Table 2. The difference in time required to perform open tray impression versus digital impression

Open tray impression		Digital impression	
Efficiency	time required(s)	Efficiency	time required(s)
Try selection	$120 \pm 2.5$	Patient information	$35.08 \pm 3.75$
Try perforation	$208.69 \pm 3.14$	Laboratory prescription	$19.68 \pm 1.98$
Adhesive application	$27.58 \pm 7.5$	Upper Scan	$205.95 \pm 17.88$
Upper impression	$450.56 \pm 18.68$	Lower Scan	$260.84 \pm 16.56$
Lower impression	$446.10 \pm 10.74$	Scan with scan body	$98.58 \pm 6.45$
Bite registration	$120.45 \pm 10.84$	Bite scan	$36.38 \pm 6.78$
Total treatment time	$1373.38 \pm 29.55$	Total treatment time	$656.51 \pm 29.11$

All data are presented as mean  $\pm$ SD. Measured time is recorded as seconds.

Table 3. Score of patient's perception (VAS) about open tray impression versus digital impression

VAS score			
Topic	Open tray impression	Digital impression	P-value
Comfort of impression	48.55 ±14.69	95.35± 15.44	0.004*
Time involved	35.69± 17.58	98.44± 18.59	0.01*
Smell-Taste	33.78 ±16.35	91.58 ±15.69	0.003*
Voice-Heat	45.25 ±22.5	88.85 ±17.58	0.018*
Dental sensitivity	33.45± 12.6	91.58± 15.69	0.22*
Breathing difficulty- -gag reflex	22.58 ±19.5	97.5 ±25.3	0.044*
Total evaluation score	219.3±88.9	563.3±160.44	0.038*

Visual Analog Scale (VAS) ranging from 0 (not satisfactory) to 100 (very satisfactory).

\*Statistical significance level  $p < 0.05$ -t test.

individual steps of the digital impression technique included the mean time for entering patient's personal data (35.08±3.75 s) and entering the laboratory prescription time (19.68±1.98 s). The mean digital impression times for the upper and lower jaws were 466.79±33.56 s, and

with the scan body, it was 98.58±6.45 s, with a mean bite scan time of 36.38±6.78 s.

Table 3 presents the evaluation scores (VAS) and the patients' concerns regarding implant impression techniques. The mean scores for subjects' evaluation criteria regarding the two

Table 4. Participants' preferences about impression techniques according to the 8-item questionnaire

Preferences	Conventional	Digital
When it comes to impression procedures, which technique do you prefer for taking impressions for the second time?	0%	100%
When considering two different impression procedures, the question arises: which technique creates a more comfortable experience for you?	0%	100%
When it comes to the process of impression taking, which technique do you find preferable in terms of the amount of time it takes to complete the procedure?	0%	100%
During the impression process, which method of sensation do you favour: the sense of taste and smell or the sensation of heat and sound?	0%	100%
Which technique do you favour based on the size of the intra-oral scanner or impression tray used?	0%	100%
Which technique do you prefer specifically for patients who experience sensitivity in their gums or teeth during the process?	0%	100%
When it comes to the issue of experiencing discomfort in breathing during the process of taking an impression, which approach do you find preferable?	0%	100%
When it comes to impression procedures, which technique do you prefer to be used in order to avoid triggering the gag reflex?	0%	100%

impression techniques were significantly different ( $p < 0.001$ ). Notably, all subjects expressed a preference for the digital impression technique ( $p < 0.001$ ).

Patients' preferences and self-concerns about the impression techniques, based on an 8-item comparative questionnaire, are detailed in Table 4.

## Discussion

Recently, intra-oral scanners have emerged as an alternative to traditional impression techniques in dental implant restorations. Many implant companies have introduced scanning abutments (scan bodies) for their implant systems. Simultaneously, dental laboratories are undergoing a digital transformation in their production technology, utilizing digitized files in a CAD-CAM environment to design crown and bridge structures over natural abutments. The provision of scan bodies to dental laboratories by implant companies has enabled the scanning and digitization of models with implant analogs, making CAD-CAM methods viable for manufacturing implant abutments, crowns, and bridges.<sup>5</sup>

This technological evolution has extended to dental offices, introducing intra-oral scanners for documenting implant-supported reconstructions. This approach simplifies workflows, particularly for dental laboratories, as the need for model scanning is eliminated, with digital scans directly originating from the dental office. Intra-oral scans in dental offices may also offer increased accuracy, as fewer steps are involved in obtaining the digital model required for CAD planning in the laboratory.<sup>7</sup>

In our clinical study, the digital impression technique demonstrated superior effectiveness compared to the traditional impression technique, depending on the clinical situation. To ensure objectivity and minimize bias, the study

population was standardized and homogenized, including patients with no prior dental history of traditional or digital impressions. This approach was supposed to prevent bias related to patients-reporting experience with dental impression procedures.<sup>10</sup>

The focus of this study was primarily on assessing the efficiency of the two implant impression techniques and patient preferences under controlled clinical conditions. Significant variations were observed in mean total treatment time and assessment outcomes between the impression techniques. An analysis of the time required for open tray impressions versus intra-oral scanning revealed that digital impressions consistently took significantly less time. Patients also expressed a preference for digital impression techniques due to their convenience, leading to the reduced number of return visits and retreatments, ultimately enhancing treatment outcomes and providing a more comfortable experience in the dentist's chair.<sup>12</sup>

The study results indicated that the efficiency of the digital impression technique was significantly higher than that of the traditional impression technique ( $p < 0.001$ ). The assessment of treatment time for each step showed significant differences between the two techniques ( $p < 0.001$ ), reinforcing the patient-friendliness of digital impression technology ( $p < 0.001$ ). These findings underscore the reasons why participants favoured the digital impression technique over the traditional one.

Despite these insights, the study has limitations, such as the restriction to one operator performing the impression technique to avoid potential inter-operator errors. Additionally, time factors associated with traditional impression techniques, such as pouring and mounting models, trimming molds, and applying mold spacers, were not considered in this study. Future investigations should explore the accuracy of impressions obtained by both experienced and

unskilled users, as well as compare complete and partial impressions to provide a more comprehensive understanding of digital and traditional impression techniques.

## Conclusions

In conclusion, the digital implant impression technique outperformed the open tray impression method in terms of efficiency, resulting in a reduced overall treatment duration for the digital approach. Participant perspectives unequivocally favoured the digital impression technique, highlighting its preference and effectiveness over the open tray method. Furthermore, the results suggested that, under the expertise of a skilled operator, the digital impression technique delivered heightened comfort during treatment compared to the conventional approach.

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