Clinical Working Time and Patient Satisfaction Outcomes: A Crossover Trial Comparing Digital and Conventional Implant Impression Techniques

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Aim: To compare patient-reported outcomes and record time efficiency for intraoral digital and analogue implant impressions made in bilateral distal extension cases with 3 units implant supported restorations.

Materials and Methods: The digital impression using a TRIOS 3Shape intraoral scanner IOS as well as classical polyvinyl-siloxane impression material (PVS) were both performed on eight patients in a crossover study, for bilateral distal extension cases with 3-units screw- retained implant-supported restorations each side of the oral cavity. Visual analogue scale (VAS) questionnaires were used to assess the degree of convenience-related aspects and patients' satisfaction. Furthermore, the working time for each impression procedure was documented separately. The data were obtained and analyzed statistically by independent t-test using IBM SPSS 20 at a 5% level of significance.

Results: All participants would choose the digital pathway if given the choice between the two approaches based on a VAS score between 0 and 100. Secondly, there was a noticeable increase in intraoral scanning (IOS) speed at 6.45 min (SD± 0.94) in contrast to the conventional analogue method with 22.15 min (SD± 1.59) P <0.05.

Conclusion: According to the results of the study, both impression techniques captured the 3D implant placement satisfactorily for all study participants. However, the intraoral scanning impression was superior to the traditional impression in terms of patient outcomes and clinical working time.

Keywords: Impression efficiency, Implant impression techniques, Direct digital workflow, Patient preference, Patient satisfaction.

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Introduction

Impressions in implant dentistry play a major role in determining the outcome of the implant- supported prosthesis. It is highly essential to accomplish a passivity between the implant and the prosthesis to ensure the long-term success of the prosthesis. For this reason, an accurate impression technique recording the three-dimensional position of a dental implant in the oral cavity is mandatory.[1, 2]

Four categories of treatment results for implant therapy can be identified: (1) longevity and survival, (2) physiological impact, (3) psychological influence, (4) and economic issues.[3] This classification contains areas of main significance to patients, as well as outcomes of indirect concern, which may be of greater interest to the doctor. As a result, both clinicians' and patients' feedback should be included when assessing the efficacy of implant treatment.[4]There is still a dearth of scientific data in the literature on patient satisfaction rates and the analysis of the psychological and social effects of implant therapy.[5]

The majority of research focused solely on edentulous patients using implant-supported removable prosthesis. In such circumstances, patient satisfaction was primarily assessed regarding masticatory function and ability to communicate. Today, patients need less time-consuming and minimally invasive therapeutic options instead of functional implant rehabilitation strategies. [6] In general, patients anticipate a favorable clinical outcome. They focus on treatment regimens that are more convenient. With the advent of digital technology in dental dentistry, patients have benefited from shorter clinical treatment times and simplifying protocols. Additionally, patients can avoid harm during traditional impression making procedures by using intraoral scans(IOS), which reduce the risk of gagging, suffocation, and taste irritation.[7]

Digital implant impression has been proposed as a beneficial alternative to conventional impressions, as they can previsualize the area of interest in three dimensions, save the time, and optimize patient outcomes.[8-10] Moreover, overcoming the possibility of deformation linked to the use of impression materials and enhancing workflows because a missing area may be rescanned rapidly . In contrast, if errors are detected during a conventional analogue impression, the operator must redo the entire process. Additionally, digital models make data storage easier and less costly by eliminating the demand for physical storage area, and the files can be stored and transported electronically as digital information.[11, 12] In vitro studies showed that several IOS systems and traditional impression techniques have similar levels of precision and accuracy for dentate complete arches.[13] Nonetheless, only limited clinical research focusing on patients' satisfaction ratings throughout traditional and digital impression processes related to implant prosthetic procedures.

The comfort of the patient is a crucial consideration when selecting the technique of impression. Patient-reported outcome measures (PROMs) are essential in dentistry practice because they make it possible to assess how patients feel about a particular therapy. Numerous studies have compared subjective patient satisfaction for traditional and digital impression methods with comfort and speed, nevertheless, due to the limited number of clinical investigations available, clear findings and definitive conclusions have not been reached.

A systematic review concluded that two RCTs evaluated procedure time and patient outcomes in tooth-supported prostheses for both conventional and digital impressions. The other 3 studies contained exclusively implant-supported restorations. [14]

Consequently, this clinical study evaluated the patient-reported outcomes and recorded clinical working time comparing conventional implant impression techniques to the intraoral scanning approach in a crossover clinical design. Patient outcomes are of growing concern in dentistry and have been incorporated into clinical studies. The null hypothesis stated that the kind of impression (conventional or digital) would not affect the working time for both impression techniques and patient satisfaction.

Material and Methods
Trial design:
This investigation was conducted as a non-randomized clinical crossover study.
Trial setting:
The study was completed at the Prosthodontics Department, Faculty of Dentistry, Tanta University.
Ethical considerations:
Following permission from the Research Ethics Committee (RP-9-20-1), the objective of the study was described to the patients and informed consent was signed before the study began. In addition, informed consent was obtained in accordance with the Human Research Ethics Committee's requirements, Faculty of Dentistry, Tanta University.
Patient Selection:
Eight patients met the inclusion and exclusion criteria were chosen from the prosthodontic department clinic at Tanta University, Faculty of Dentistry.
Inclusion criteria:
Patient age (30-55) years old, the bone height and width must fulfill the criteria for implant placement, devoid of any systemic diseases that may interfere with soft or hard tissue healing, all patients should have an acceptable maxillomandibular relationship and sufficient inter-arch space, patients must maintain proper dental hygiene.
Exclusion criteria:

Individuals with psychiatric or neurological conditions that may interfere with appropriate oral hygiene, parafunctional habits, alcoholics and heavy smokers, and patient with immune-compromised status.

Three months after osteointegration of dental implants, two different implant-level impression procedures: Conventional impression and digital impression were performed on all eight partially edentulous patients lacking all mandibular posterior molars and premolars excepting bilateral first premolars as last standing teeth. Digital impression was captured with peek scan bodies (Bredent Copa sky, Germany) screwed onto the implant and a TRIOS 3Shape wired intraoral scanner (version 1.3.4.2, Denmark) according to the manufacturer's recommendation. While for the conventional impression splinted open tray approach with polyvinyl-siloxane material (Zhermack, ELITE HD+S.P. A, Italy) and an implant impression coping (Bredent Medical Copa sky, GmbH&Co.KG Germany) were used. All procedures were carried out by a single skilled operator.

The clinical outcomes of impression techniques:
The clinical consequences of impression techniques were assessed through evaluating patient satisfaction as the primary outcome while comparing the two-impression protocol. Subsequently, the work time required for conventional and digital impression was recorded as a secondary outcome.

a) Patients satisfaction: Visual analogue scale (VAS) questionnaires were used to compare the two impression procedures.[15,16] All patients responded to five questions about their perception and opinions on treatment time, convenience level, anxiety, nausea sensation, and the possibility of pain sensation. VAS ranged from 0 to 100 score.

The Questionnaire

Patient name:
Date:
Score:
1. **What is your opinion on the treatment time required for the impression procedure?**
   - VAS: unsatisfactory 0-100 excellent
2. **How convenient was the impression procedure for you?**
   - VAS: unsatisfactory 0-100 excellent
3. **How high was your anxiety level before the impression procedure?**
   - VAS: low 0 – 100 high
4. **Did you experience a nausea sensation during the impression procedure?**
   - VAS: no sensation 0 – 100 a lot of sensation
5. **Did you experience pain during the impression procedure?**
   - VAS: no pain 0 – 100 a lot of pain

b) Working time: The time required to obtain an acceptable impression was recorded in minutes separately for each impression technique. If necessary, retakes of conventional impressions and rescans of areas missing (digital impressions) were recorded as additional events and extra working time.[17]

All data were collected and statistically analyzed.

Statistical methodology:

Data were entered into the computer and IBM SPSS software package version 20.0 was used to analyze the data. the **Shapiro-Wilk test** was used to verify (Armonk, NY: IBM Corp) the normality of the distribution was verified using. The quantitative data were explained using mean, standard deviation, median and range (minimum and maximum). The acquired data were considered significant at the 5% level. The used test was:
1 - Paired t-test for normally distributed quantitative variables, to compare between two impression techniques.

Results

On visual analogue scale analysis (VAS), demonstrated mean satisfaction scores related to the opinion of the patient regarding the treatment time needed for impression technique, patient convenience, anxiety level, nausea and pain sensation during impression making and the results showed a significant difference between two techniques ($p \leq 0.05$), and patients always preferring the digital approach over the conventional one Table (1) Figure (1).

Table 1: Comparison between digital and conventional according to patient satisfaction

Patient Satisfaction	Digital (n=8)	Conventional (n=8)	t	P
Q1				
Mean ± SD.	82.50 ± 4.63	67.50 ± 8.45	3.850*	0.006*
Median (Min. – Max.)	82.50 (75.0 – 90.0)	70.0 (50.0 – 75.0)		
Q2				
Mean ± SD.	88.13 ± 4.58	70.63 ± 6.78	8.283*	<0.001*
Median (Min. – Max.)	90.0 (80.0 – 95.0)	72.50 (60.0 – 80.0)		
Q3				
Mean ± SD.	25.0 ± 22.68	66.25 ± 5.18	4.438*	0.003*
Median (Min. – Max.)	17.50 (10.0 – 80.0)	65.0 (60.0 – 75.0)		
Q4				
Mean ± SD.	18.13 ± 5.94	61.25 ± 9.91	9.744*	<0.001*
Median (Min. – Max.)	20.0 (10.0 – 25.0)	60.0 (50.0 – 80.0)		
Q5				
Mean ± SD.	15.0 ± 5.35	65.0 ± 8.45	16.733*	<0.001*
Median (Min. – Max.)	15.0 (10.0 – 25.0)	65.0 (55.0 – 80.0)		

SD: Standard deviation, t: Paired t-test, p: p-value for comparing between Digital and Conventional,
*: Statistically significant at p ≤ 0.05

Regarding recording clinical working hours for both conventional and digital implant impression procedures revealed that the intraoral scanning impression approach took (6.45± 0.94) min, while the conventional one took (22.15±1.59) min, these mean differences have statistical significance ($p \leq 0.05$).

Table 2: Comparison between digital and conventional impressions according to work time.

Work time (min.)	Digital (n=8)	Conventional (n=8)	T	P
Mean ± SD.	6.45 ± 0.94	22.15 ± 1.59		
Median (Min. – Max.)	6.09 (5.30 – 8.0)	21.88 (19.97 – 25.17)	35.734*	<0.001*

SD: Standard deviation, t: Paired t-test, p: p-value for comparing between Digital and Conventional, *: Significant statistically at p ≤ 0.05

Discussion

The hypothesis that there would be no difference between the conventional and digital impressions was rejected. Patient preferences were assessed using scale questionnaires or through a visual analog scale. These surveys investigated factors like comfort, taste irritation, gagging and pain sensation from the patient's viewpoint during traditional or digital impressions. According to the findings of this study, there was a significant difference and participants appear to gravitate towards the intraoral scanning technique over the conventional one.[6, 17, 18] This could be due to today's patients' expectation for minimally invasive and comfortable treatment. As the removal of impression materials is one of the main causes leading to improved comfort and absence of the pain during the transfer of the implant position and other anatomical features from the oral cavity to the virtual setting. Furthermore, the 3-D Previsualization enabled a real-time verification of the scanning accuracy. Moreover, in the analogue technique, an unsatisfactory impression necessitates remaking the entire impression. In contrast, only the missing and unsatisfactory parts were rescanned for the intraoral scanning impression technique. Hence, this technique shortens the procedure working duration while boosting comfort and acceptance for patient, these results are in agreement with[12, 18-20]

Four studies comparing patient-reported outcome measures (PROMs) between conventional and digital impressions concluded that the digital technique was more comfortable causing less anxiety and sense of nausea, according to a systematic review. Regardless of patient comfort just one study found no difference between the techniques. While two studies had shown the conventional method to be less time-consuming, three studies found the digital method to be less time-consuming. [14]

Regarding to the time efficiency, after recording the working time of each technique, the results of the current study showed a marked difference between traditional and digital impressions techniques. The results were by a Joda and Brager [6] Gjevold et al[17] and Schepke et al[21] who concluded that the intraoral scanning impression technique required less overall working time.

On the other side, Benic et al[22] and Wismeijer et al[18] noted that the conventional method required less total working time. The fact that Benic et al[22] observed less time for the conventional impression may be demonstrated by their conventional closed-mouth impression technique, as it allowed the impression of both jaws and the occlusal registration in one phase. Because of this, the traditional impression was more time efficient than the digital scanning technique. Likewise, Wismeijer et al[18] are contrary to the findings of the current study who showed that the conventional analogue technique needed less time to complete the procedure. The authors believe that the reduction in procedure working time related to scanning proximal surfaces can be challenging and difficult due to the scan body's position which may impede the scanner assessment.

Conclusion

Based on the findings of this clinical

study, it was determined that:

1. The digital implant impression was more patient-friendly and popular than the conventional impression method.
2. When compared to the conventional technique, the digital impression one was more convenient for both the dentist and the patients.
3. Intraoral scanning is an acceptable alternate to conventional impression procedures, causing less discomfort for individuals who are sensitive to nausea, taste, and breathing difficulties compared to the traditional technique.

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Data availability: The data generated during the current study are available on reasonable request from the corresponding author.

Declarations

Ethics approval and consent to participate: All participants signed the informed consent.

Competing interests: The authors have declared that no competing interests exist.

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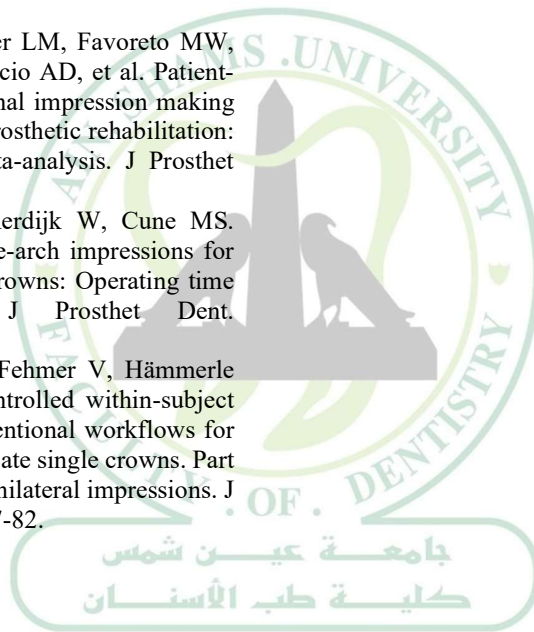
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