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CLINICAL SCIENCE

Digital versus analog complete-arch impressions for single-unit premolar implant crowns: Operating time and patient preference

Ulf Schepke, DDS,[a] Henny J. A. Meijer, DDS, PhD,[b] Wouter Kerdijk, PhD,[c] and Marco S. Cune, DDS, PhD[d]

ABSTRACT

Statement of problem. Digital impression-making techniques are supposedly more patient friendly and less time-consuming than analog techniques, but evidence is lacking to substantiate this assumption.

Purpose. The purpose of this in vivo within-subject comparison study was to examine patient perception and time consumption for 2 complete-arch impression-making methods: a digital and an analog technique.

Material and methods. Fifty participants with a single missing premolar were included. Treatment consisted of implant therapy. Three months after implant placement, complete-arch digital (Cerec Omnicam; Sirona) and analog impressions (semi-individual tray, Impregum; 3M ESPE) were made, and the participant's opinion was evaluated with a standard questionnaire addressing several domains (inconvenience, shortness of breath, fear of repeating the impression, and feelings of helplessness during the procedure) with the visual analog scale. All participants were asked which procedure they preferred. Operating time was measured with a stopwatch. The differences between impressions made for maxillary and mandibular implants were also compared. The data were analyzed with paired and independent sample *t* tests, and effect sizes were calculated.

Results. Statistically significant differences were found in favor of the digital procedure regarding all subjective domains ($P<.001$), with medium to large effect sizes. Of all the participants, over 80% preferred the digital procedure to the analog procedure. The mean duration of digital impression making was 6 minutes and 39 seconds (SD=1:51) versus 12 minutes and 13 seconds (SD=1:24) for the analog impression ($P<.001$, effect size=2.7).

Conclusions. Digital impression making for the restoration of a single implant crown takes less time than analog impression making. Furthermore, participants preferred the digital scan and reported less inconvenience, less shortness of breath, less fear of repeating the impression, and fewer feelings of helplessness during the procedure. (J Prosthet Dent 2015;114:403-406)

In 1971, Francois Duret introduced the computer-aided design/computer-aided manufacturing (CAD/CAM) process to restorative dentistry,[1] and in 1983 he produced the first CAD/CAM dental restoration. Currently, CAD/CAM has expanded into the restorative aspects of implant dentistry, and the technology is rapidly replacing traditional labor-intensive laboratory methods for implant abutment fabrication.[2] The most frequently used in-office dental CAD/CAM technology appears to be the CEREC system (Sirona).[3]

Analog impression procedures use elastic impression materials poured with dental stone. This procedure is prone to inaccuracies.[4] In addition to other advantages of digitization,[5] the fit of CAD/CAM single crowns is better than that of analog ones,[6,7] even though the digital modeling still remains problematic, especially in areas located further from the field of interest.[8,9]

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[a]Associate Professor, Department of Fixed and Removable Prosthodontics and Biomaterials, University of Groningen, University Medical Center Groningen, Center for Dentistry and Oral Hygiene, Groningen, The Netherlands.
[b]Professor, Department of Fixed and Removable Prosthodontics and Biomaterials, University of Groningen, University Medical Center Groningen, Center for Dentistry and Oral Hygiene, Groningen, The Netherlands.
[c]Associate Professor, Department of Public and Individual Oral Health, University of Groningen, University Medical Center Groningen, Center for Dentistry and Oral Hygiene, Groningen, The Netherlands.
[d]Professor, Department of Fixed and Removable Prosthodontics and Biomaterials, University of Groningen, University Medical Center Groningen, Center for Dentistry and Oral Hygiene, Groningen, The Netherlands.

Clinical Implications

Patients to a great extent prefer digital impression making to the analog technique. Also, the digital approach is substantially less time-consuming.

Impressions and casts can be digitized at a later stage in the process, but an increasing number of clinicians prefer the direct digital impression technique.[3] Most digital impression procedures for implant-supported crowns make use of designated scan bodies, which are scanned intraorally.[10]

CAD/CAM also allows the use of improved biomaterials such as zirconia.[11] However, an additional possible advantage of digital technology is a more predictable, stress-free, and comfortable treatment for the patient. Marketing claims suggest that digital technology will optimize the treatment workflow by providing more comfort and safety for the patient and by requiring less operating time than conventional treatment ("CEREC Fact Sheet-Facts to Inspire," 2013, http://www.sirona.com/en/service/brochures). However, little peer-reviewed, published research can be found about its efficiency and patient preference in clinical practice.

One article reported an overall preference for the digital scan (iTero) compared with the analog technique.[12] However, the effect size was not mentioned, and the digital impression was not performed with the popular CEREC system.[3] Furthermore, the study was performed on a small cohort of participants, with considerable variability in the number and location of implants.

A second article reported the evaluation of in vitro conventional and digital impression making by students, which raises questions as to its external validity. It was concluded that operating time could be cut in half and that most student-operators preferred the digital approach. No information was offered regarding patient preference.[13]

Both studies used a modified visual analog score (VAS) that was successfully introduced in dentistry in 2011.[14] It seems an appropriate instrument for assessing patient preferences, even though no validation for impression making has been done to date.

Operator skills influence not only the quality of an impression[15] but also the time needed.[16] Interindividual and intraindividual differences among operators have been reported in dentistry,[17] but little is known about these differences in the field of impression making. Therefore, interindividual differences were eliminated by using a single-operator protocol.

The purpose of the present in vivo study was to examine patient perception and time consumption for 2 complete-arch impression-making methods for single implant treatment: a digital and an analog technique. We hypothesized that digital impression making requires less time than analog impression making and would be more patient friendly.

Table 1. Exclusion criteria

- Missing teeth mesial or distal from implantation site.
- Orthodontic treatment at time of impression making.
- Severe bruxism.
- Acute periodontitis.
- History of implant loss.
- Documented extreme gagging reflex.
- Poor medical condition (ASA[19] score 3 or higher).
- Previous therapeutic radiation of head-neck region.
- Chronic pain in orofacial system.
- Younger than 18 years at time of inclusion.
- Reduced mental capacity.

ASA, American Society of Anesthesiologists.

MATERIAL AND METHODS

A single-center, prospective clinical study was conducted, for which 50 participants needing a single crown in the mandibular or maxillary premolar region were recruited. Exclusion criteria are listed in Table 1. Participants were informed about the purpose of the study, treatment alternatives, and associated risks. Permission from the medical ethics committee was granted, and informed consent was obtained.

Standard implant treatment consisted of the placement of a single implant (Astra OsseoSpeed TX 3.5x, 9, 11, or 13 mm in length; Dentsply Implants). Restorative treatment was started 3 months after placement.

An analog impression with a polyether material in an open, semi-individual impression tray (Impregum; 3M ESPE) and a digital impression (Cerec Omnicam; Sirona) were made on the same day by the same experienced operator (U.S.) after the placement of an impression post or scan body. A lip and cheek retractor (OptraGate, Ivoclar Vivadent) was used to improve access to the oral cavity during both procedures. The order in which the impressions were made was determined by randomization.

Operating time was measured with a stopwatch once the participant had received instructions and had been prepared for either procedure (Table 2). Impression time for the analog complete-arch impression started when the polyether mixing machine (Pentamix 2; 3M ESPE) button was pressed.

When the impression was removed from the mouth after 6 minutes, the participant was instructed not to rinse; saliva was suctioned by the dental assistant. Subsequently an irreversible hydrocolloid impression (Alginate CA37 Fast Set; Cavex Holland BV) was made of the opposing arch. After that impression was removed, the participants were asked to briefly rinse a single time before an interocclusal record was made (Futar Fast, A-silicone; Kettenbach GmbH & Co KG).

Table 2. Preparation time (not taken into account)

Analog
- Preparing participants: settling time in chair, napkin, instructions, lip retractor, saliva suction.
- Choosing semiindividual impression tray (Border-Lock disposable), drilling hole above implantation site and adapting tray to participant's mouth.
- Choosing correct impression tray for opposing arch.
- Coating tray with adhesive (polyether tray adhesive; 3M ESPE).
- Installing correct impression post in implant for open impression technique.
- Disinfecting impressions and preparing box for shipping.
- Filling in analog order format.

Digital
- Preparing participants: settling time in chair, napkin, instructions, lip retractor, saliva suction.
- Powdering or dusting was not applied before impression making.
- Starting computer and software.
- Attaching correct scan-post to implant.
- Filling in digital patient administration system and sending it digitally to laboratory.
- Calculation time to create virtual model.
- Calculation time to fix position of virtual models.
- Disinfecting scan unit.

Time measurement stopped when the silicone material was removed from the participant's mouth after 60 seconds of setting time.

The impression time for the digital complete-arch impression, including interocclusal record making, started when the intraoral scanning device was removed from the scan unit. First, the arch with the implant was scanned, followed by the opposing arch and the buccal scan for the interocclusal record. Timing stopped when the device was returned to the unit.

Patient preference was determined by using a straightforward questionnaire with a VAS (range 0-100). The questionnaire inquired as to the inconvenience experienced with both procedures, a perceived feeling of shortness of breath, whether the participant would be anxious about having to undergo the procedure again, a perceived sense of helplessness during the procedure, and their preference (Supplemental Table 1). Paired sample *t* tests were used to compare the results of the 2 groups after verification of normality. Normality was assumed when skewness and kurtosis were both not significant. When the data were not distributed normally, a Wilcoxon signed-rank test was performed. When the paired sample *t* test was significant, the Cohen d was calculated as a measure of effect size; when a Wilcoxon signed-rank test was significant, r was calculated as effect size instead. For the Cohen d, effect sizes of .2, .5, and .8 are considered small, medium, and large, respectively. For r, effect sizes of .1, .3, and .5 are considered small, medium, and large, respectively.[18] In addition, differences between maxillary and mandibular impressions were explored by using independent samples *t* tests.

RESULTS

Of the 50 participants in this study, 66% were women. The mean age was 47.7 years (SD=12.8). Nine participants

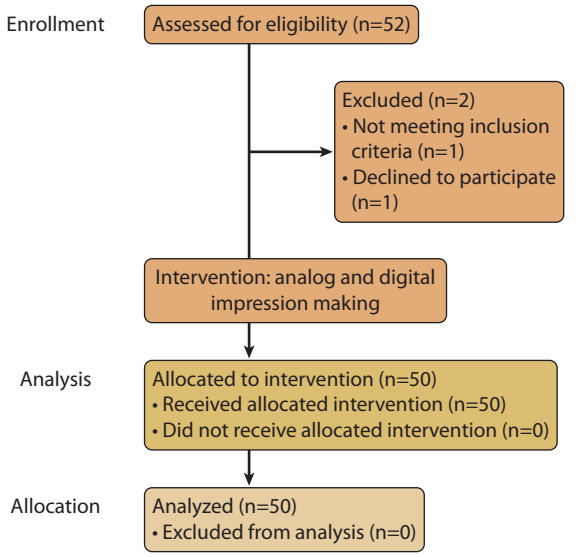

Figure 1. Inclusion and intervention modified CONSORT 2010 flow diagram.

(18%) had their implant impressions in the mandible (n=50; missing 15 maxillary first, 26 maxillary second, 2 mandibular first, and 7 mandibular second premolars). Two participants were excluded from the study (Fig. 1). Only the data regarding the question concerning anxiety about repetition were not normally distributed.

The mean time needed to make a digital impression was almost half the time needed to make an analog impression (6 minutes and 39 seconds [SD=111 seconds] versus 12 minutes and 13 seconds [SD=84 seconds]). The difference was significant (t[49]=19.0; $P<.001$) with a large effect size (d) of 2.7.

In the questionnaire, participants indicated that they experienced significantly more discomfort during the analog impression making (t[49]=6.2; $P<.001$; d=.9). During the analog procedure, participants experienced significantly more shortness of breath than during the digital impression (t[49]=5.1; $P<.001$; d=.7) and significantly more feelings of helplessness (t[49]=4.1; $P<.001$; d=.6). Furthermore, participants were significantly more afraid of having to repeat an analog procedure than of repeating a digital procedure (T=9; $P<.001$; r=.5).

During the analog procedure, participants experienced more feelings of helplessness when an impression was made of the maxilla than when an impression was made of the mandible (t[17.9]=2.8; $P=.011$; d=0.9). A trend was identified showing that making a digital impression from the maxilla took less time (mean 6 minutes and 25 seconds; SD=108) than making an impression from the mandible (mean 7 minutes and 24 seconds; SD=102) (t[48]=2.0; $P=.053$; d=0.6). No such difference was found for analog impression making. Of 50 participants, 41 (82%) preferred the digital impression making method over the analog. Five participants

(10%) indicated no preference, and 4 participants (8%) indicated a preference for the analog method.

DISCUSSION

Significant differences were found in time consumption and patient preference in favor of the digital technique. Effect size can provide information as to the practical relevance of the findings. In the current study, medium to high effect sizes were found for the difference in time consumption and patient preferences. This confirms that digital impression making may indeed be a better method with regard to these outcomes.

Only participants in need of a single premolar implant were included for the purpose of standardization. Duration and patient preference for an oral impression-making procedure may depend on factors such as the number and location of the implants needed and other patient factors. However, these factors were not considered in this study. Because the implant impression-making procedure lends itself well to standardization, it was incorporated into this study design. This inclusion criterion may have limited the generalizability of the findings. However, the findings from this study are similar to those of other studies comparing digital and analog impression making.[12,13]

Even though the use of VAS is common in the field of dentistry, it has chiefly been used and validated for assessing pain and anxiety.[14] Validated questionnaires in different languages for patient preference in terms of impression-making techniques are desirable but not yet available, which is a weakness in this evaluation.

CONCLUSIONS

Within the limitations of this study, it was concluded that for an experienced dental clinician, a digital complete-arch impression of a single implant unit takes considerably less time than an analog complete-arch impression. Moreover, patients strongly prefer the digital approach.

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Corresponding author:
Dr Ulf Schepke
UMC Groningen, Center for Dentistry and Oral Hygiene
Department of Fixed and Removable Prosthodontics and Biomaterials
Building 3216, Room 205
A. Deusinglaan 1
9713 AV Groningen
THE NETHERLANDS
Email: u.schepke@umcg.nl

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Supplemental Table 1. Questionnaire

About completing this questionnaire:
We have just made a digital scan/analog impression. We would like to know how you experienced this technique. Please provide an answer by drawing a line. If you place your line in the middle, your answer is "neutral."
Example:
Disagree |————————|————————| *Agree*
Your answers will be treated as confidential!
1. The impression-making procedure bothered me.
A great deal |————————————————| *Not at all*
2. Impression making made me feel unpleasantly short of breath.
Disagree |————————————————| *Agree*
3. I am anxious about having to undergo the impression procedure again.
Disagree |————————————————| *Agree*
4. During the impression procedure I experienced feelings of helplessness.
Disagree |————————————————| *Agree*
Thank you very much for your cooperation!
After both impressions, the participant was asked whether he or she preferred the analog or the digital technique, or whether it made no difference.