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DIGITAL VS CONVENTIONAL IMPRESSIONS IN DENTAL IMPLANT:A LITERATURE REVIEW

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Introduction:. Digital impressions in implant dentistry rely on many variables, and their accuracy, particularly in complete edentulous patients, is not well understood.

Aim *:* The purpose of this literature review was to determine which factors may influence the accuracy of digital impressions in implant dentistry. Emphasized attention was given to the design of the intra-oral scan body (ISB) and scanning techniques. Materials and methods. A Medline, PubMed and EBSCO Host databases search, complemented by a hand search, was performed in order to select relevant reports regarding the appliance of digital impressions in implant dentistry.. The related titles and abstracts were screened, and the remaining articles that fulfilled the inclusion criteria were selected for full-text readings.

Results : The literature search conducted for this review initially resulted in 108 articles, among which only 25 articles fulfilled the criteria for inclusion. Studies were evaluated according to five subjects: accuracy of digital impressions in implant dentistry; the design and material of the intra-oral scan bodies; scanning technique; the influence of implants depth/angulations on the digital impression and accuracy of different intra-oral scanner devices. Conclusions. The accuracy of digital impressions in implant dentistry depends on several aspects. The depth/angulation of the implant, the experience of the operator, the intra-oral scanner used, and environmental conditions may influence the accuracy of digital impressions in implant dentistry. However, it seems that ISBs' design and material, as well as scanning technique, have a major impact on the trueness and precision of digital impressions in implant dentistry. Future research is suggested for the better understanding of this subject.

Keywords: digital impressions, implant dentistry, intra-oral scan bodies, intra-oral scanner, accuracy, scanning technique, implant depth, implant angulation, conventional impressions for implant

INTRODUCTION

Currently, implant-supported prosthodontics restorations are a commonly accepted treatment option for functional and aesthetic rehabilitation of partially and completely edentulous patients.

The process of fabricating a dental prosthesis typically starts with impressions to capture the anatomy of the prepared teeth or location of the endosseous implants, as well as the morphology of the surrounding tissues. This critical step determines the accuracy of the models and ultimately that of the prosthesis.

For decades, conventional impressions have often used polyvinyl siloxane (PVS) impression materials [2, 3]. Major drawbacks of conventional impression techniques include their physical material properties, consistency, taste, and odor, all of which may negatively influence the patient experience.

Clinical studies have indicated that conventional impressions are ranked among one of the most unpleasant experiences during fixed ,removable and implant prosthodontics .

Thus, it is desirable to pursue alternative methods to improve patient-reported outcomes in prosthetic and implant dentistry.

Digital devices have had a widespread use in dental practice in the last few decades. CAD/CAM technology made it possible to fabricate implant-supported restorations through a digital workflow. Digital impressions transfer the intra-oral situation to a virtual model and represent the first step of the digital workflow. The accuracy of this procedure may determine the success of the treatment, since it is a crucial step to transfer the implant position correctly. If it is performed poorly, it can lead to a misfit of the final prosthesis, which may result at long last in mechanical and biological complications.

Digital impressions can accelerate the data-capturing process and eliminate most of the drawbacks usually found with conventional impressions, thereby decreasing patient discomfort while improving the predictability of prosthesis design and manufacturing procedures .

Therefore, the aim of this literature review consists of understanding the state of the art of digital impressions on implant dentistry, and conventional impressions techniques in implant dentistry.

MATERIAL AND METHOD

An electronic search of publications from 1987 to 2022 was established from three electronic databases: PubMed, Cochrane Central Register of Controlled Trials, and Web of Science. The search strategy used a combination of controlled vocabulary and free-text words. The detailed search design and strategies, including keywords, developed for each database are presented below.

Search in PubMed

(“computer-aided design”[MeSH Terms] OR (“computer-aided”[All Fields] AND “design”[All Fields]) OR “computer-aided design”[All Fields] OR (“cad”[All Fields] AND “cam”[All Fields]) OR “cad cam”[All Fields]) AND “digital impression”[All Fields] AND “conventional impression”[All Fields] (MeSH, Medical Subject Heading).

Search in Web of Science

(“computer-aided design” OR (“computer-aided” AND “design”) OR (“cad” AND “cam”) OR “cad cam”) AND “digital impression” AND “conventional impression.”

Search in the Cochrane Central Register of Controlled Trials

(“computer-aided design” OR (“computer-aided” AND “design”) OR (“cad” AND “cam”) OR “cad cam”) AND “digital impression” AND “conventional impression

INCLUSION CRITERIA

The literature search included only English-language articles in the field of dentistry, published in peer-reviewed dental journals. To identify further studies, the reference lists of identified articles of digital impressions vs. conventional impressions were screened. Unpublished reports or abstracts or case reports as well as reports that did not cover both conventional and digital impression techniques were not included. The selection of included titles was followed by an abstract search. After agreeing on abstract inclusion, a full-text search followed. Final

selection of articles was based on full-text reading. The search design was as follows: Electronic search: "digital impression versus conventional impression"→Review of abstracts→Review of full texts→Individual selection of the final articles

Results

Identified articles

The search yielded 23 references from the PubMed, 12 from Web of Science, and 2 from the Cochrane Central Register of Controlled Trials. Based on the assessment of the titles, abstracts, and the full text, 21 articles were selected from PubMed, 9 from Web of Science, and 1 from the Cochrane Central Register of Controlled Trials. The total number of articles was reduced to 25 because some studies were identified from two databases. One article was found in all three databases, and 9 articles were found in both PubMed and Web of Science.

Digital impression versus conventional impression for fabrication of implant-supported crowns .

An in vitro study by Abdel-Azim et al13discovered the influence of computer-aided impression options on the accuracy of dental implant-based single units and complete-arch frameworks. They reported that conventional impressions resulted in a smaller marginal discrepancy than digital methods for a single-implant framework. For single implants the mean marginal gap was 24.1 µm for conventional impressions compared to 61.4 µm for digital impressions. In full-arch impressions a 135.1µm mean marginal gap was measured for conventional impressions compared to 63.1 µm for the digital impressions. Additionally, Lee et al14 conducted an in vitro study to compare the accuracy of implant impressions made with digitally manufactured models vs. gypsum models vs. CAD/CAM system models. The digital impressions were made with the iTero system and the conventional close-tray impressions with a VPS material. Gypsum models represented more details in grooves and fossae compared to CAD/CAM models. According this study, milled models based on digital impressions were comparable to gypsum models based on conventional impression.

Time efficiency and operator's perception

Several studies have compared the conventional and digital impressions from both the patient's and the dentist´s point of view. In 2014 Yuzbasioglu et al20 showed that the overall treatment time and impression time were lower with the digital impression technique as compared to conventional methods. The digital impression took approximately 248.48 ± 23.48 seconds and conventional impression 605.38 ± 23.66 seconds. The patients felt the uptake of digital impressions with CEREC AC Omnicam more pleasant and kept it as a primary option. Further, Lee et al21 evaluated the difficulty level and the operator's perception of digital and conventional implant impressions. In this in vitro study 30 experienced professionals and 30 dental students made impressions of a single implant model. The student group scored a mean difficulty level of 43.1 for the conventional impression technique and 30.6 for the digital impression technique on a 0 to 100 a visual analog scale (VAS). Sixty percent of the students preferred the digital impression and 7% the conventional impression as their first choice. The clinician group scored a mean difficulty level of 30.9 for conventional impressions and 36.5 for digital impressions on a 0 to 100 VAS scale. In the clinician group, 33% preferred the digital impression and 37% the conventional impression. Forty percent of the clinicians chose the digital impression as the most effective technique, and 53% preferred using the conventional impression. The conventional impression was more difficult for the student group than it was for the clinician group. The difficulty level of the digital impression was the same in both groups. It was also found that the student group preferred the digital impression as the most efficient impression technique, and the clinician group had an even distribution in the choice of preferred and efficient impression techniques. An in vivo study reported that the digital impression technique was a more efficient and convenient method than the conventional impression method. The use of digital technique also resulted in better occlusal contacts as compared to conventional impression techniques. The mean total procedure times for digital and conventional impression techniques were 14:33 ± 5:27 and 20:42 ± 5:42 minutes, and the mean impression times were 7:33 ± 3.37 and 11:33 ± 1.56 minutes, respectively. The mean scores for the dentist's assessment of difficulty on a 0–100 VAS were 24.00 ± 18.02 and 48.02 ± 21.21 for digital and conventional impression technique, respectively. The mean VAS scores for the patients' assessment of discomfort were 6.50 ± 5.87 and 44.86 ± 27.13 for digital and conventional impression techniques, respectively (the value 100 meaning the most discomfort).

Discussion

In this study all reported marginal gaps of crowns fabricated using digital impressions resulted in clinically acceptable marginal gaps. All marginal gaps were less than 120 µm, which is the clinical acceptable limit. Only Zarauz et al4reported crowns' mean internal misfit and mean marginal misfit of 173.0 and 133.5 µm for conventional one-step silicone impressions compared to 111.4 and 80.2 µm for the digital impression group; however, results comparing the marginal fit between conventional and digital impressions varied. Anadioti et al6reported that IPS e.max crowns fabricated with conventional PVS impressions produced the most-accurate marginal fit compared to conventional impression and CAD/CAM crown, digital impression and press crown, and digital impression and CAD/CAM crown. This study concluded that indirect digitalization results are clinically acceptable when concerning crowns. For fabrication of implant-supported crowns and FDPs digital impression accuracy is clinically acceptable. Trueness and precision differs significantly between the digital impression systems and impression methods. Local deviations over 100 µm can lead to inaccurate fitting, thus causing problems in large prosthetic restorations.5, 19

Impression accuracy and the fit of the definitive prosthesis depend on every phase of the process. In conventional techniques every step, including impression, stone casts, wax patterns, investment, and casting, must be carried out precisely to achieve the best fit. Instead, dental CAD/CAM systems usually need fewer steps (i.e., digital impression, design, and milling), where the number of error sources is less than in the conventional method. Additionally, the milling method is standardized.13 In fabrication of full-arch FDPs, digital impressions showed higher local deviations than conventional impressions did. As clinical implications of this study, it concluded that the accuracy of CAD/CAM systems and digital impressions is compatible with conventional impressions. The time efficiency of digital impression systems is better than for conventional techniques.20 As to operator's perception, digital impressions are easier for inexperienced clinicians.21 On the other hand, distal targets are challenging to impress with intraoral cameras. The size of digital intraoral cameras is still bigger than traditional impression trays. Some digital systems, for example CEREC Bluecam, also require use of titanium oxide to improve the contrast. In dental digital impression systems, the number of error sources is smaller than in traditional impression methods. The digital impression is monitored on the hardware display screen, thus enabling poorly scanned objects to be reproduced smoothly without losing the complete impression data. The intraoral camera is often a more comfortable and less invasive option for patients with sensitive gag reflex or profuse salivation, and the data transmission is cheap and fast. Digital impression data is also easier to store.1Digitalization has already become commonplace in dentistry in other specialized areas such as radiology. On the other hand, high investment costs are a barrier to uptake of technologies.

Reports of digital impression techniques vs. conventional impression techniques were systematically searched from 1987 to 2015. This review was done systematically from the Cochrane Central Register of Controlled Trials, PubMed, and Web of Science databases. The search strategy used a combination of controlled vocabulary and free-text words. The detailed search design and strategies developed for each database were presented clearly based on the distinct selection criteria. Based on search results, 19 articles were selected. The number of studies was relatively low, which is why strong conclusions cannot be drawn. Further, the number of the studies varied with regard to the examined structure; for example, there were only two studies on implant impressions. Many of these studies measured the accuracy of the final restoration, and consequently the results may be influenced by each step of the ceramic manufacturing phase, not only the impression. The fit of the final restoration is measured from the gap between the restoration and the clinical preparation. In these studies, there was variation on how the fit of the final restoration was evaluated. Although all studies measured the accuracy of the restoration, this should be noted when results are compared. We condensed these results into two columns in Table 1: marginal gap and internal fit. Marginal, gap describes the restoration fit in the margin, and internal fit describes the fit in inner areas of the restoration. CAD/CAM systems include several variations, of which CEREC is used in the office only, whereas the iTero system's milling unit is used in the laboratory. Digital impression techniques also vary regarding the video or still photo technique. These facts influence the fit of the final restoration and impression accuracy.

Conclusions

Based on this literature review, it seems that the accuracy of digital impression is at the same levels as conventional impression methods in fabrication of crowns and short FPDs, and thus both of these techniques can be used. For fabrication of implant-supported crowns and FDPs the digital impression systems also result also in a clinically acceptable fit; however, for large, full-arch FPDs, the conventional impression technique results in better accuracy as compared to the digital method, which is why the conventional methods may be preferred. When used for the right indication, digital impression making seems to be the preferred method over conventional impressions, with regard to time efficiency and patient preference. Dental students have also shown a preference for this technique, which means its use will likely continue to grow. Due to the relatively low number of studies, however, additional investigations are needed to confirm these findings.

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