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ACCURACY OF DIGITAL VS CONVENTIONAL IMPRESSION TECHNIQUES: A NARRATIVE REVIEW

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ABSTRACT

Computer-aided design and manufacturing (CAD/CAM) techniques are increasingly used in dental restorations, yet many approaches start with traditional gypsum casts based on conventional impression techniques. Despite advancements in impression techniques and materials, results in clinical practice often remain unsatisfactory. Digital impressioning procedures offer promise in improving restoration accuracy by eliminating error-prone conventional methods and ensuring high standardization. This review aims to compare the accuracy of digital versus conventional impression techniques in dentistry. A comprehensive search of electronic databases from 1987 to 2023 was conducted, focusing on English-language articles in peer-reviewed dental journals. Inclusion criteria required studies comparing both digital and conventional techniques. Results from PubMed, Cochrane Central Register of Controlled Trials, and Web of Science yielded 19 articles meeting selection criteria. While systems like CEREC have been commercially available for over 25 years, newer digital impressioning devices like Lava C.O.S., iTero, and TRIOS are gaining prominence. The marginal accuracy of restorations is crucial for periodontal health, with internal fit important for restoration longevity. Studies comparing digital and conventional impressions show comparable accuracy, meeting information transfer requirements from patient to laboratory. Digital impressions offer advantages in reducing chair time and patient discomfort, leading to improved treatment effectiveness. However, challenges remain in establishing protocols for evaluating intraoral impression accuracy and ensuring precision. Overall, digital impression systems demonstrate comparable accuracy to conventional techniques, with added benefits in efficiency and operator ease, though challenges with distal targets persist.

Keywords: Digital Impression, Conventional Impression, Prosthodontics, Fixed Partial Dentures.

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INTRODUCTION

The use of computer-aided design and manufacturing processes is becoming more prevalent in the creation of dental restorations. But the majority of methods are restricted to the dental laboratory and begin with scans of an old-fashioned gypsum cast made using an old-fashioned impression method. The outcomes in clinical daily practice are often still inadequate despite all the advancements in imprint procedures and materials; hence, more work has to be done to enhance them [1]. There are several factors that contribute to this, none of which can be attributed to a particular stage in the production of prosthetic restorations. Although the workflow's task sequences may be standardized to lessen these issues, they cannot be completely eradicated. Given that digital impressioning technologies by definition do away with the tendency to mistake traditional impression and gypsum model casting and provide a high level of standardization, they might be a useful tool in this context for improving the accuracy of dental restorations [2]. Digital impressioning devices may immediately input the data they collect into the digital CAD/CAM manufacturing cycle. The traditional impression may also be thought of as a way to send data from the patient to the dental laboratory from the perspective of information processing. Therefore, intraoral data collection may be used to represent both digital impressioning and traditional impression-taking. It seems sense to move the scanning process to the patient and scan the preparations in their mouth directly in order to reduce process mistakes that arise from collecting impressions and creating models [3]. Over the course of its more than 25 years in commercial use, the CEREC system—which was the first to use this strategy—has undergone constant improvement. In the meantime, the fourth generation of hardware (CEREC Bluecam) is available. On the other hand, the chairside fabrication of partial crowns and inlays is the primary emphasis of this technology [4]. This is also true for the E4D system, which D4D Technologies, TX, USA developed and is primarily accessible in the USA. Both techniques, meanwhile, have never been shown to be a viable substitute for the custom of capturing impressions. Numerous statistics on CEREC technology are accessible in dentistry literature. Still, not much information about the E4D system could be found. In general, CEREC yields satisfactory outcomes [5, 6], but the accuracy attained is not superior to that of traditional imprint methods [6, 7]. Conversely, newly developed digital impressioning systems like the TRIOS digital impressioning device (3Shape, Denmark), the iTero system (Cadent, NJ, USA), and the Lava C.O.S. (3M ESPE, MN, USA) are more geared towards generic tooth replication. The producers of the aforementioned gadgets have expanded their indications as a result. While the internal fit of a ceramic restoration is thought to be significant for its lifetime, the marginal correctness of a restoration is seen as a necessary requirement for good periodontal health [8–10].

MATERIALS AND METHODS

Search Strategy:

To comprehensively review the literature on the accuracy of digital versus conventional impression techniques in dentistry, an extensive electronic search was conducted covering publications from 1987 to 2023. This search spanned three major databases: PubMed, Cochrane Central Register of Controlled Trials, and Web of Science. Utilizing a combination of controlled vocabulary and free-text words, the search strategy was meticulously designed to capture relevant studies. The keywords employed in the search strategy included "computer-aided design," "CAD/CAM," "digital impression," and "conventional impression." The strategy aimed to

encompass all relevant articles exploring the comparative accuracy of digital and conventional impression methods.

Inclusion Criteria:

The literature search focused exclusively on English-language articles published in peer-reviewed dental journals. To ensure the inclusion of comprehensive studies, only articles comparing both digital and conventional impression techniques were considered. Additionally, to broaden the scope, reference lists of identified articles were screened for potential studies. Exclusion criteria encompassed unpublished reports, abstracts, case reports, and studies lacking coverage of both digital and conventional impression methodologies.

Search Design:

The search design followed a systematic approach, beginning with electronic searches across the selected databases using the key phrase "digital impression versus conventional impression." Subsequently, abstracts were reviewed to assess relevance, followed by a thorough examination of full texts for final article selection.

RESULT

A total of 17 references from PubMed, 9 from Web of Science, and 1 from the Cochrane Central Register of Controlled Trials were found via the electronic search. A thorough assessment of the complete texts, abstracts, and titles led to the selection of 16 publications 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 19 due to database overlaps. Surprisingly, PubMed and Web of Science shared seven papers, but only one item was present in all three databases.

Digital impressioning tools satisfy the standards for transmitting data from the patient's mouth to the dental laborator by providing an accuracy level equivalent to traditional impression procedures. Overall treatment periods and impression times vary significantly between digital and traditional imprint processes, according to studies comparing the two methods. Furthermore, compared to traditional approaches, digital impressions have shown considerably fewer internal and peripheral gaps. Different findings have been obtained from recent research comparing digital and traditional procedures; some have shown that digital impressions are more accurate than conventional impressions. Digital impressions have proven advantageous despite variations in methodology and assessment methodologies, especially with regard to accuracy and insensitivity to implant angulation.

Digitally imprinted crowns have AMI and IF values that are similar to those of traditionally manufactured crowns. The examined digital impressioning devices fulfill the accuracy standards for the process of transferring information from the patient's mouth to the dental laboratory and provide results that are equivalent to those of traditional impression procedures [11].

A statistically significant difference was seen in the mean total treatment times ($p < 0.001$), and a statistically significant difference was also observed in the mean impression times ($p < 0.001$). There was no statistically significant difference between the mean tray selection time for the traditional impression method and the mean patient information entry time for the digital impression technique ($p > 0.05$). Statistically significant differences ($p<0.001$) were seen between the mean adhesive application time for the traditional impression method and the mean laboratory prescription time for the digital impression technique. A statistically significant difference ($p < 0.001$) was seen between the mean bite registration time for the traditional approach and the mean bite scan time for the digital technique [12].

The imprint method had a significant impact on the gap's size (P =.001). The digital technique's internal and marginal gaps (49.43μ and 60.07μ, respectively) were found to be substantially less than the traditional method's values (91.88μ and 96.96μ, respectively—P < .001). Finish line placements did not significantly affect the fit and marginal gap of copings (P =.54 and.243, respectively) [13].

Two of these studies [14, 15] used master models with five identical implants at 0°, 10°, and 15° angles to compare the open tray CI method with splinting and DI. They used STL file superimposition to analyze accuracy. While Amin et al. [15] discovered higher accuracy with DI, Papaspyridakos et al. [14] showed no differences between the approaches. Implant angulation did not seem to have a substantial effect on impression accuracy, according to either study. Abdel-Azim et al. [16] used a master model with four parallel implants to compare closed tray CI with DI that was done at the abutment level. Under a microscope, the marginal difference between restorations made with digital and traditional procedures was used to assess accuracy. DI was more accurate.

Menini et al. [17] also collected impressions at the abutment level; however, they determined that DI was more accurate when comparing three-dimensional deviations using CMM. Alikhasi et al. [18] compared CI and DI in implants with internal and exterior connections. CMM measurements of three-dimensional deviations revealed that DI was more precise and independent of connection type or angulation. Based on the most current research [19], two discovered higher DI accuracy [24, 26], and five discovered higher CI accuracy [19, 21, 23, 25, 27]. Out of the five publications that followed, three used comparable methodologies [19, 21, 20] concerning impression-taking methods and accuracy assessment (CMM). Two of the three trials that found no differences between CI and DI used CIs without splinting [20, 21]. In terms of implant angulation, angulation was shown to have no influence on any of the five CE studies that examined its impact in both DI and CI. According to research by Alikhasi et al. [18] and Ribeiro et al. [21], angulation doesn't change DI, but it does change CI. They found that DI was more accurate only when implants were parallel, but neither CI nor DI changed when implants were angulated.

The AMI derived from various digital impressioning techniques is consistent with existing reseaIt was also found by Syrek et al. (2010) that the edges of Lava zirconia crowns made from intraoral Lava C.O.S. scans were 49 μm more accurate than the edges of traditional crowns made from a two-step putty-wash impression [28]. These data may be compared to our findings since Syrek assessed the AMI using the same methodology as Holmes [29] recommended. For the CEREC system, the majority of researchers evaluated inlay and onlay restorations; however, there is less data for crown AMI.

The reduction of sitting time is the main benefit of digital impressions. There was a significant difference in the participants' assessment ratings ($p < 0.001$) and the mean total treatment duration ($p < 0.001$) with respect to impression procedures. The digital impression procedures also improved the patients' degree of comfort and acceptance of the therapy ($p < 0.001$). Digital impressions have been shown to increase treatment efficacy while decreasing retreatment and recurrent visits. More comfort and a more enjoyable time in the dental chair will benefit the patients.

The absence of a defined technique for assessing the accuracy of intraoral impressions is the primary barrier to conducting in vivo research on impression-taking. A high-precision device must replicate the locations of implants in the mouth to create a reference model. However, due to the unique anatomical features of the oral cavity, this replication is not possible with high-precision equipment like an extraoral laboratory scanner or a CMM. On the other hand, these tools assess test models and reference models in in vitro research. The difference between the reference and test models may be used to calculate the trueness of a statement [31]. However, as reference optical scanners cannot be utilized intraorally, in vivo investigations are limited to indirect trueness analysis via the use of microscopic and/or radiographic examination of prosthetic constructs made from CIs or DIs, as well as Sheffield testing [32]. While trueness cannot be compared in in vivo research, precision (reproducibility) may be assessed by calculating the

differences between a set of impressions made using the same method on a single subject. Mühlemann et al. [33] compared the accuracy of DI and CI (closed tray impressions at implant level) by putting STL files on top of five patients who had SIs of the same brand in the back area. The CI was found to be more accurate.Each stage of the procedure is critical to the final prosthesis's fit and impression accuracy. To get the optimum fit when using traditional methods, each step—imprint, stone castings, wax patterns, investment, and casting—must be completed exactly. Instead, compared to the old technique, dental CAD/CAM systems often need fewer processes (i.e., digital impression, design, and milling), and there are fewer mistake sources. The milling process is also standardized. Thirteen digital impressions showed more local variations than traditional impressions in the manufacture of full-arch FDPs. The research indicated that the accuracy of digital impressions and CAD/CAM systems is comparable to that of traditional impressions, with potential therapeutic implications. Digital imprint technologies provide a higher time efficiency than traditional methods [34]. In terms of the operator's perspective, novice physicians find it simpler to make digital imprints. However, it is difficult to impress distal targets using intraoral cameras. Digital intraoral cameras continue to be larger than conventional impression trays in terms of size [35].

CONCLUSION

In conclusion, the comparison between digital and conventional impression techniques in dentistry reveals a nuanced landscape of accuracy and efficiency. While digital impressioning devices demonstrate comparable accuracy to conventional methods and offer advantages in terms of reduced treatment times and lower internal and marginal gaps, variations exist in the findings across different studies. Some studies report greater accuracy with digital impressions, particularly in terms of unaffectedness by implant angulation, while others favor conventional techniques. Despite these variations, the overall trend suggests that digital impressions hold promise for improving the accuracy and efficiency of dental restorations. Further research and standardization of evaluation methods are necessary to fully understand the comparative benefits and limitations of digital and conventional impression techniques in clinical practice.

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