DIGITAL IMPRESSIONS VERSUS TRADITIONAL IMPRESSIONS: AN OVERVIEW ON ACCURACY, TIME AND PATIENT PREFERENCES

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Abstract

Aim of the study This study aimed to evaluate the time efficiency and accuracy of digital scanning compared to traditional impression methods in dentistry, as well as their impact on patient comfort and satisfaction. **Materials and methods** Bibliographic searches were conducted in databases (PubMed, Scopus, Web of Science), applying relevant keywords to identify studies comparing digital and conventional impression techniques in dentistry. The data was extracted and graphically represented. **Results** Data from clinical studies indicated mixed conclusions regarding accuracy and impression parameters. Time spent on impressions seems to be less for digital techniques, but results are conflicting. Patients reported increased comfort and a clear preference for digital scans due to their less invasive nature and reduced discomfort. **Conclusions** Integrating digital scanning technology into modern dental practices offers significant benefits in terms of procedural efficiency and patient satisfaction, while accuracy and time depend by circumstances such as edentulism type and length of scan.
Keywords: Intraoral scanner, Digital impression, Traditional impression, Edentulous patients

INTRODUCTION

The quality of life has significantly improved, leading to increased life expectancy and thus, a rise in partial or complete edentulism [1]. Prosthetic rehabilitation needs to be functional and aesthetic whether it is supported by implants, teeth, or mucosa, thus necessitating the accurate reproduction of oral structures [2]. Therefore, one of the crucial phases for successful restoration is the impression-taking process. Conventional impressions (CI) techniques have several drawbacks, including patients' low tolerance to the texture, taste, and smell of the material. Furthermore, the physical properties of the material can pose challenges in workflow management. To overcome these limitations and due to technological advancements, alternative methods have been identified [3,4]. A viable alternative to conventional impressions is using intraoral scanners (IOS), which can capture dental arches, implants, and tissues using high-resolution cameras, allowing three-dimensional previewing of scanned structures. This

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reduces working time and workflow complexity, yielding better patient-reported outcomes. Additionally, the impressions taken have a lower risk of distortion, hence resulting in highly precise outcomes [5]. These outcomes contribute to better treatment outcomes and patient satisfaction. However, intraoral scanning also has limitations, such as issues connected to patients who salivate excessively, reflective restorations, floating mucosa, and various scanning protocols [6–8].

Patient comfort is a crucial factor that can influence the choice of impression technique [3,9,10]. Patient-Reported Outcome Measures (PROMs) and Patient-Reported Experience Measures (PREMs) measure how patients perceive the experience and are of paramount importance in dental practice [10–13]. Previous studies comparing conventional impressions (CI), and digital impressions (DI) concluded that up to 100% participants prefer DIs in all evaluated aspects, including overall comfort, time required and perceived sensations. Overall discomfort, impression time, gag reflex, breathing difficulties, and dental sensitivity have been reported reduced for DI, promoting this method as preferable to patients [5,14].

The aim of this overview is to assess recent in-vivo studies investigating differences between digital and conventional impression-taking, in terms of accuracy, time required and patient preferences and/or satisfaction levels.

MATERIALS AND METHODS

This study represents a scoping review. The research protocol was formulated following the guidelines provided by the PRISMA Extension for Scoping Reviews (PRISMA- ScR). This review was designed to answer the following study question: *How do digital and conventional impressions compare in terms of patient preferences, time required, accuracy and other parameters?*

Eligibility Criteria

The inclusion criteria were formulated as follows: (1) articles relevant to dentistry and impression techniques; (2) articles providing sufficiently detailed technological insights for direct applicability of digital impressions (file formats, data processing techniques); (3) articles comparing DI to CI and evaluating any of the following outcomes: accuracy, precision, trueness, validity, reliability, repeatability, reproducibility, time required, patient preferences, patient satisfaction, patient stress, ; (3) studies published in the last 5 years, in English; (4) interventional and observational studies, of prospective, retrospective and cross-sectional designs, reviews, systematic reviews, and meta-analyses; (5) in-vivo studies on humans; .

The following exclusion criteria were considered: (1) articles that present insufficient information or data; (2) studies that do not directly relate to the specified study subjects or that do not compare DI to CI; (3) articles unavailable in full-text form; (4) in-vitro studies, ex-vivo studies, case reports, conference abstracts, editorials; (5) studies on particular impression types (such as impressions for implant restorations, impressions for facial prosthetics, impressions on patients with maxillary defects, etc). The 5th criterion was set due to the particularities involved by these types of impressions.

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Information Sources and Search Strategy

The electronic literature search was conducted by two independent researchers across multiple databases (PubMed, Scopus, and Web of Science), restricting results from 27 September 2019 to 27 September 2024. The search consisted of keywords (such as Medical Subject Head- ings or MeSH) for conventional impressions, digital impressions, impression outcome variables and patient preferences, combined with Boolean operators "AND" and "OR", as well as keyword searching of title, abstract and text words. Restrictions regarding language (English) and species (humans) were applied. The exact search terminology used for each database is available in **Supplementary Materials – Annex 1**.

Articles selection was conducted in three phases:

1. Initial search to gather a comprehensive set of potentially relevant articles.
2. After the de-duplication of results, titles and abstracts of results were screened by two independent researchers and selected according to the inclusion and exclusion criteria. A third researcher was available for conflict resolution. Results considered relevant were retrieved in full-text form.
3. Full-text articles were assessed by two independent researchers for relevance and selected based on inclusion and exclusion criteria. A third researcher was available for conflict resolution.

References of studies to be included were screened to further identify potentially relevant studies. Relevant articles were categorized and analysed to evaluate the use of intraoral scanners versus conventional impressions in prosthodontics, focusing on patient preferences, time required, accuracy and other parameters and clinical outcomes. The search results and selection process were documented using a PRISMA flow chart to ensure transparency and replicability of the review process.

A data-charting form was used to extract the data from each study. Thus, names of the first authors, titles, years, place, types, participants, and the results of the studies were recorded in the data extraction form on the Microsoft Excel software. Finally, the data obtained from the previous stage were classified using the thematic analysis method.

RESULTS

A total of 829 articles were identified after applying the search strategy to the 3 databases. After de-duplication, a number of 570 studies remained available for screening. These articles were independently screened by two researchers (CA and KA) and selected based on their titles/abstracts and their relevancy to the study question. 14 more studies were identified by references screening. A total of 46 records were considered for full-text retrieval and were further assessed for eligibility by two independent researchers. A third researcher (NM) was available for conflict resolution. Finally, a total of 30 publications were included in this review.

The selection process, along with the in clusion decision, is shown in **Figure 1**.

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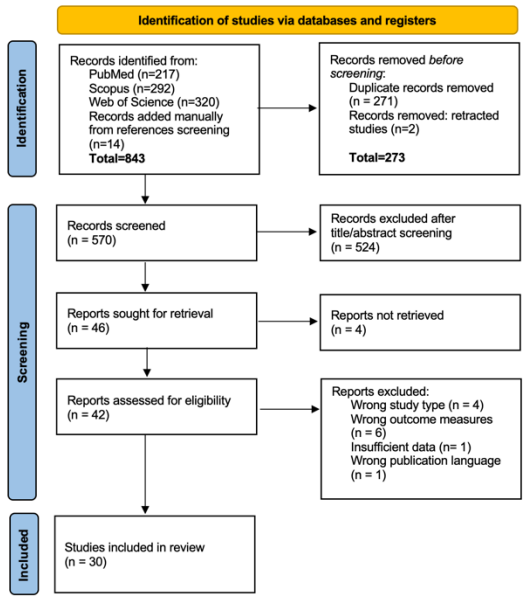

Figure 1. Prisma Flowchart for study selection process

There were 11 review-type studies, and 19 clinical studies included. **Table 1** summarises the main characteristics and conclusions of clinical studies. **Table 2** summarises the main characteristics and conclusions of review studies.

The included studies were analysed by frequency descriptive statistic methods for selected parameters: year of publishing, geographical area, study design, dental status assessed and outcome measures. The results of the analysis are presented in **Figures 2-6**.

Most studies were published in 2023 (**Fig.2**).

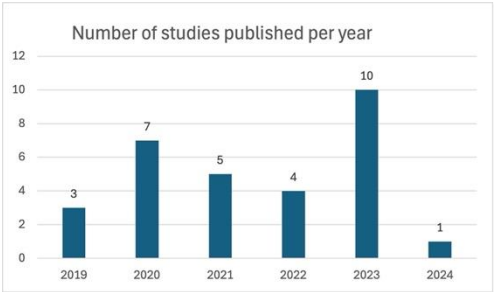

Figure 2. Graphic representation of included studies by year published

Germany was the most frequent geographical area of origin for included studies (**Fig.3**).

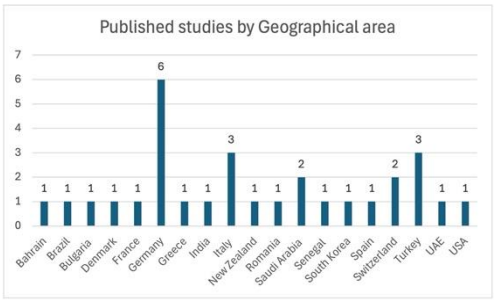

Figure 3. Graphic representation of included studies by geographical area

There were 13 clinical studies included, 6 clinical trials, 6 systematic reviews, 2 systematic reviews and meta-analyses, 2 umbrella reviews and 1 network meta-analysis (**Fig.4**).

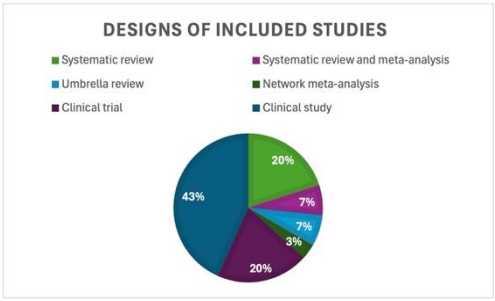

Figure 4. Graphic representation of included studies by study design

Studies which analysed fully dentate, partially and fully edentulous patients were included, as well as studies assessing mixed dentition patients (**Fig.5**).

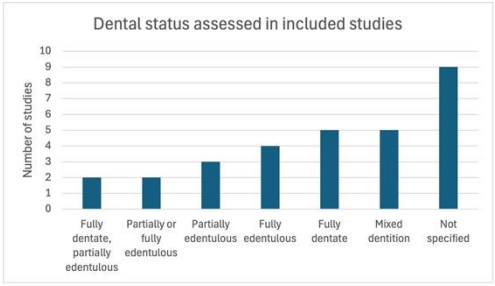

Figure 5. Graphic representation of included studies by dental status of patients

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The outcome measures (time, accuracy/trueness, PROMs) were graphically represented according to the frequency of assessment (**Fig.6**). One study assessed time as a single outcome variable [29], 5 studies assessed accuracy as single outcome [21,22,24,30,44] and 2 studies assessed trueness as single outcome [23,31], while PROMs were assessed as single variables in 2 studies [37,39]. 3 studies assessed operator preference among outcome measures [16,20,26]. The rest of the studies assessed two or more outcome variables simultaneously.

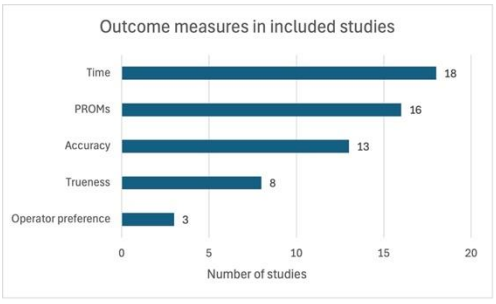

Figure 6. Graphic representation of included studies by outcome variables

In terms of accuracy, DIs reported various results regarding to the type of edentulism, length of scan and local conditions. Regarding patient preferences, all clinical studies assessing PROMs or PREMs reported that patients preferred DIs. These results were mirrored in the included review studies. 3 studies had paediatric study populations, and all concluded DIs were more comfortable for the young patients [18,25,28]. Time required for impression taking was lower for DIs in 4 out of the included clinical studies [15,19,28,29] and it equivalent for the two techniques in 2 studies [18,25]. 3 review studies concluded DI techniques are faster than Cis [34,40,42], one review concluded DIs take longer than CIs [43], one review reported equivalent time expenses between the two [36] and one review stated that the results regarding time are inconclusive [41].

DISCUSSIONS

Evaluating and improving technologies and procedures used in dentistry, including IOS, are crucial aspects for advancing dental practice. In this context, we will analyse and discuss the conclusions of included studies reported to existing literature, focusing on impression parameters such as accuracy, PROMs and time expenditure of digital scanning in dentistry, consequently highlighting both the advantages and limitations of existing technologies and providing suggestions for future research directions and developments in the field.

1. Impression parameters

The accuracy and precision of digital scanning are influenced by various factors, like ambient lighting and the extent of the scanning [45–47]. A study by Kihara et al [48] evaluated the accuracy and practicality of various intraoral scanners and their verification methods. The results highlight that brightness and colour temperature influence the accuracy of intraoral scanners [48].

The impact of ambient lighting conditions on digital scanning accuracy in dentistry has been highlighted by other authors as well, with results showing that ambient lighting significantly affects scanning precision, with room lighting conditions (RL) yielding the best results. Additionally, it was found that the extent of digital scanning influenced

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accuracy, with lower accuracy values for more extensive scans [49]. Digital scans have shown acceptable accuracy and precision for most tested intraoral scanners [50]. A study by Floriani et al. [51] highlighted that digital impressions taken with intraoral scanners (IOS) demonstrated higher accuracy compared to conventional impressions. Variation in impression accuracy was observed depending on several factors such as IOS type, scanning strategy, and modification techniques. Most IOS systems achieved or exceeded the clinically acceptable threshold for linear accuracy [51]. However, the umbrella review by Afrashtehfar et al [34] concluded that there are similar levels of accuracy between IOS and CI for less than 4-unit fixed dental prostheses. For more extensive definitive fixed solutions or removable prostheses, the CI is recommended [34]. The use of additional reference objects can enhance these aspects, especially for partially edentulous models [52]. A study by Schimmel et al. [53] assessed the impact of additional reference objects on the accuracy of intraoral scanners for both partially and completely edentulous patients. Results showed that the addition of artificial landmarks improved the trueness of all measured parameters for the tested intraoral scanners. However, there were no significant differences in precision and trueness between scans with and without additional artificial landmarks for partially edentulous conditions, highlighting the versatility of IOS for most prosthodontic cases. Operator experience is another variable that can determine the quality of an IOS. A study by Zarauz et al [54] aimed to evaluate how the age of the operator, training, and type of intraoral scanner affect the accuracy of digital scanning. The results showed that training had a significant impact on accuracy, and newer software increased the truth of the scans. Furthermore, the age of the operator influenced the accuracy of inexperienced operators, suggesting the need for adequate training, especially for older individuals [54].

2. PROMs and PREMs – patient preferences, comfort and perceptions

Several reviews assessed patient preferences and clinical outcomes between IOS and CI [14,55–57]. Data focusing on patient preferences, comfort or discomfort, nausea, unpleasant taste, and breathing difficulties were collected. Results generally tend to reveal patients' preference of this technique, demonstrating significant benefits in terms of comfort and reduced discomfort. This reveals intraoral scanning as a viable alternative to conventional impression procedures, offering a more pleasant experience for patients, particularly those sensitive to taste, nausea, and breathing difficulties [39]. Furthermore, children's and adolescents' preference for digital impressions opens an opportunity for creating positive experiences at the dentist, facilitating proper treatment and the development of a relation based on trust with the dental professional [18,25,28,41,58]. These findings underscore the ongoing importance of integrating digital technologies in dental practice to enhance patient experience [59].

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3. Time required

Time and cost are decisive elements in choosing dental prosthetic treatments [60]. Digitalization has revolutionized prosthodontics, reducing the number of visits and the time patients spend in the chair, while also improving workflow efficiency. Modern IOSs provide fast and high-resolution scans [61]. IOSs are also ergonomically friendly and reduce clinicians' fatigue [62]. This aspect is particularly important, as it helps maintain efficiency and effectiveness. These factors not only enhance accuracy but also patient comfort, minimizing errors related to human factors. For single crowns and quadrant impressions, DI methods generally surpass conventional techniques in speed [61,63]. However, the performance of complete arch scans is less consistent, with some digital scans taking longer than their conventional counterparts [43]. This variability underscores the importance of choosing the right scanner based on specific clinical needs and the type of prosthetic being fabricated. Other studies concluded IOS is superior to CI in terms of speed, regardless of the complexity of the scan (quadrant or complete arch) and the nature of the restoration (tooth or implant-supported) [42]. Overall, IOS seems a more time-efficient solution; patient's acceptance of the method might make DIs preferable even in cases difficult to scan for various reasons, which require repeated scans.

4. Comparison between traditional and digital impressions

The shift towards digital impressions in dental practice represents a significant advancement in both technology and patient care. While traditional methods still hold value and applicability, the benefits of digital impressions align closely with the goals of modern dental practice. **Table 3** provides a comparative analysis of traditional versus digital dental impression techniques, highlighting significant differences across various aspects of dental practice.

Table 3. A comparative analysis of traditional versus digital dental impression techniques

Category	Traditional Impressions	Digital Impressions
Accuracy	Varies depending on impression material properties, technique and operator experience	Generally offers high and consistent accuracy
Detail Reproduction	Errors may occur in capturing fine details	Excellent at capturing fine details
Patient Comfort	May cause discomfort, gagging, and anxiety due to large volumes of physical materials intraorally.	More comfortable for patients, reduces anxiety and discomfort.
Patient Preference	Less preferred due to discomfort and duration	Preferred due to comfort and speed, associated with higher degrees of satisfaction and reduced anxiety.
Execution Time	Longer working time due to handling and setting times.	Significantly reduced working time, excepting particular situations.
Material Efficiency	Uses physical materials which can require ulterior cleaning and can cause waste.	Eliminates the need for physical materials, minimizing waste
Prosthetic Outcomes	Potential variations due to inaccuracy of impression materials	Reliable prosthetic outcomes due to high accuracy
Technology Involved	Limited to physical materials, relying on operators' skill and experience	Digital technology involved, such as 3D imaging and mapping, AI and image analysis and processing software
Applicability	Effective for all types of restorations	Ideal for cases without extended edentulous gaps
Initial Costs	Lower initial costs but steady costs over time.	Higher initial investment

5. Further research directions

As digital scanning technology continues to evolve, ongoing research is

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necessary to evaluate new advancements, including improvements in scan accuracy, speed, and integration capabilities with other digital dentistry tools. Research should also extend to the effectiveness of digital scans for more complex restorations like full-arch prosthetics, focusing on accuracy and practicality. Furthermore, investigating Patient-Reported Experience Measures (PREMs) and Patient-Reported Outcome Measures (PROMs) will provide deeper insights into patient satisfaction and comfort across different demographic groups.

The long-term durability and effectiveness of restorations created using digital scans compared to those made with traditional impressions need to be explored to assess their longevity and performance over time. Lastly, assessing the impact of operator skill and training on the effectiveness of digital impression techniques would help identify necessary training protocols and support the development of educational programs for dental professionals transitioning to digital methods. These research directions would not only address current gaps but also enhance the understanding of digital technologies integration in dental practice, leading to improved patient care and treatment outcomes.

6. Study limitations and strengths

This study provided an overview of recent in-vivo studies comparing digital and conventional impressions. However, this review did not include conclusions of in-vitro studies, which could provide additional technical data to confirm or infirm clinical findings. Studies on impressions for implant prosthetic treatments were not included, due to the particularities of techniques involved and added variables that do not apply to standard impressions, such as implant angulation. Therefore, this study does not provide an overview applicable to all prosthodontic cases. Some of the systematic reviews included did not include meta-analyses. Furthermore, due to small sample sizes (for clinical studies), results could still need further confirmation by large-scale clinical trials.

However, this study has several notable strengths. It followed PRISMA guidelines for scoping reviews, ensuring transparency and protocol rigour. The study emphasizes the importance of precise criteria for article selection to ensure the relevance and quality of the information. A comprehensive and exhaustive search strategy ensured a large number of results, while still maintaining relevance to studied domains. Results were presented systematised and tabulated for clarity and reading efficiency, while graphic statistics of extracted data provide visual impact and ease of interpretation. The selected in-vivo clinical articles provide technical and practical insights, enhancing both academic knowledge and clinical practice in dentistry. The inclusion of umbrella reviews in this study strengthens the strength of evidence, thus ensuring scientific information quality and applicability.

CONCLUSIONS

The accuracy and trueness of digital impressions is comparable to that of traditional impressions, confirming intraoral scanning as an optimal alternative to conventional impression techniques. However, the differences between the two techniques show in other aspects. Digital

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impressions might reduce the time required for both quadrant and complete arch scans compared to traditional impression methods, but reported results are inconclusive. Digital impressions were preferred by patients (including children and adolescents) in all studies evaluating PROMs and PREMs. The digital approach minimizes patient discomfort, leading to improved patient standards in the rapidly evolving field of dental medicine [25]. For clinicians transitioning to or expanding their use of experiences and satisfaction. The patients' and the operators' preference for digital impressions, and the integration and facilitation of dentistry workflows seem to be the main advantages of digital impression techniques over conventional impression techniques.

Table 1. Main characteristics and conclusions of clinical studies

Author	Year	Design	Dental status	Sample size	Outcome variables	Intraoral scanner	CI material	Outcome assessment methods	Conclusions
Bock et al. [15]	2023	cross-sectional	fully dentate, orthodontic patients	30	accuracy, time	Primescan, Trios 4, Medit i700, Emerald S	alginate	3D analysis software for trueness/ precision. Stopwatch for time	The transfer accuracy in terms of trueness and precision with IOSs was better than or at least equivalent to the data from CIs for all measured variables. Significantly less time was needed for a digital full-arch impression compared to a CI.
Cheah et al.[16]	2020	cross-sectional	NS	40	time, operator preference (familiarity, confidence levels)	TRIOS 3	alginate	VAS for familiarity, perceived confidence levels, difficulties and user-friendliness of each tech- nique.	Final-year undergraduate students perceived the CI technique to be easier and faster than digital scanning, there was a significant increase in the level of confidence after only one occasion of DI.
Chebib et al.[17]	2019	cross-sectional	fully edentulous	12	trueness, PROMs (preference)	TRIOS 3	alginate and medium-viscosity PVS and ZOE	3D analysis software for trueness/ precision ; VAS for comfort, taste, gagging, burning sensation during the procedure and subjective satisfaction	Edentulous impressions made with PVS, and the DI had similar deviations and may yield clinically acceptable results. ALG should be discouraged for definitive impression making for complete dentures.
Glisic et al.[18]	2019	cross-sectional	mixed dentition, orthodontic patients	59	PROMs (preference), time, accuracy	TRIOS Classic	alginate	VAS for time perception, comfort, gag reflex, breathing, smell/sound, taste/vibration, and temperature; Anxiety scale; Stopwatch for time.	Children preferred intraoral scan rather than alginate impression. Chairside time was equal for the two procedures.
Jánosi et al.[19]	2023	cross-sectional	fully dentate	28	time, trueness, PROMs (comfort)	TRIOS 3	alginate	3d analysis software. VAS for patient confort. Stopwatch for time	The DI is more comfortable and accepted by the patients and takes less time. No significant differences existed between DI and CI for trueness.
Karasan et al.[20]	2023	cross-over	partially edentulous	12 (28 FDPs)	occlusal adjustment, operator, and PROMs (preference)	Trios 3	vinyl siloxane	3d analisys software. VAS for patient confort and operator preference	The complete digital workflow with digital static bite-registration provided high occlusal accuracy for short-span tooth-supported FDPs. The patient and operator preferences significantly favored the digital workflow.
Lee et al.[21]	2020	cross-sectional	fully dentate	20	accuracy - 3D surface analysis	TRIOS and iTero	alginate	3D surface analysis software	There was an average of 0.10 mm of overall deviation between conventional alginate impressions and in vivo full dental arch intraoral scans.
Lo Russo et al.[22]	2020	cross-sectional	fully edentulous	16	accuracy - 3d surface analysis	Trios 3	polysulfide	3D surface analysis software	The difference between CI and DI (-0.02 mm) was not statistically significantly different and was not clinically significant for removable denture fabrication.
Onbasi et al.[23]	2022	cross-sectional	fully dentate	31	trueness	CEREC Omnicam (CO) and Trios 3 (TR)	polyether and addition curing silicone material	3D surface analysis software	Full-arch trueness was comparable for CI and DI. The DI devices yielded higher local deviations within the complete arch. DI of the complete arch are a suitable and reliable alternative to CI. However, they should be

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									used with caution in the posterior region.
Saravi et al.[24]	2023	cross-sectional	partially edentulous	12	accuracy - 3D surface analysis	True Definition	vinyl siloxane ether	3d analysis software	DI shows high accuracy when capturing hard tissues such as abutment teeth, but exhibits greater deviations in mobile mucosal areas, underscoring its limitations when capturing soft tissues.
Yilmaz et al.[25]	2019	cross-over	mixed dentition	28	PROMS, time	Trios 3-Cart	alginate	VAS index, stopwatch	The digital impression was considered to be more comfortable in the assessments by both the children and the clinician. There was no statistically significant difference in time.
Yilmaz et al[26]	2021	cross-sectional	NS	60	time, operator preference	TRIOS 3	alginate	VAS for applicability, comfort, and hygiene; the State-Trait Anxiety Inventory form (STAI-TX1) for stress, and a questionnaire for the operator's impression preference.	Dental students and operators experienced in both techniques were satisfied with the digital scans and they preferred digital scans. Operators experienced with conventional impressions were satisfied with conventional impressions but didn't have a preference for the impression type.
Willmann et al.[27]	2024	cross-sectional	fully edentulous	30	trueness, time	Trios 3	alginate	3d analysis software	DI of the fully edentulous maxilla can be considered similar to conventional alginate impression except in the depressible areas.
Bosoni et al.[28]	2023	cross-over	mixed dentition, orthodontic patients	24	PROMs (preference, comfort), time	Trios 3	alginate	Visual Analogue Scale (VAS) for comfort, pain, gag reflex and difficulty in breathing,	Digital impression is preferred by children aged 6–11 years and it is significantly faster in acquisition time and more comfortable than conventional alginate impression.
Gogushev et al.[29]	2021	NS	partially edentulous	36	time	Trios	addition polyvinyl siloxane	3d analysis software	The DI technique has proven to be more efficient in terms of clinical time required for its implementation than the CI.
Liczmanski et al. [30]	2020	non-randomised comparative	mixed dentition, orthodontic patients	44	accuracy	TRIOS® Ortho	alginate	3D inspection and mesh processing software	Dimensional differences between CI and DI in the mixed dentition are clinically irrelevant for orthodontic purposes. In all clinical situations of active treatment in the mixed dentition, the intraoral scans are more detailed and less error-prone.
Schlenz et al.[31]	2020	NS	NS	30	trueness	True Definition (TRU), Primescan (PRI), CS 3600 (CAR), and TRIOS 3 (TIO)	polyvinyl siloxane	3d analysis software	DI are superior to CI regarding the ability to display the Interdental areass in PCDs.
Schmidt et al.[32]	2020	NS	fully dentate	5	trueness, accuracy	Trios3Cart, Trios3Pod, Trios4Pod, and Primescan	polyether	3d analysis software	DI demonstrated less deviation for short-span distances compared with the CI technique. However, for long-span distances, the CI provided the lowest deviation.
Yılmaz et al.[33]	2021	cross-over	fully dentate, partially edentulous	39	PROMS, time	Trios 3 Cart	alginate	Stopwatch for impression time. VAS for comfort. State-Trait Anxiety Inventory for anxiety; preference with a questionnaire	DI and CI were similar in terms of impression time and anxiety of patients. However, patients were more satisfied with the digital technique, and preferred it.

Table 2. Main characteristics and conclusions of review studies

Author	Year	Design	Dental status	Number of included studies	Outcome variables	Conclusions
Afrashtehfar et al.[34]	2022	Umbrella	fully dentate, partially edentulous, fully edentulous	11 studies, 4 studies including just clinical data	Accuracy, Trueness, PROMs (preference), time	Clinical data indicated similar accuracy between IOS and conventional impressions for less than 4-unit fixed dental prostheses. For more extensive definitive fixed solutions or removable prostheses, the conventional approach is recommended. IOS was superior in terms of patient preference and time reduction.
Ahmed et al.[35]	2023	Systematic	fully edentulous, partially edentulous	12 studies	accuracy, PROMs (acceptability), time	Digital impressions have many advantages over conventional impression procedures, they improve patient as well as operator comfort, reduce the number of visits, and improve the practice efficiency of the operator. Digital impressions exhibit comparable accuracy to conventional impressions without any statistically significant difference
Bandiaki et al.[36]	2022	Systematic and Meta-analysis	fully dentate, partially edentulous	16 studies	time, PROMs (comfort), and marginal fit of tooth-supported prostheses.	The mean clinical time and mean marginal fit was statistically similar for digital scan procedures and for conventional impression methods (P>.05). The digital scan techniques were more comfortable for patients than conventional impressions (P<.05).

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Christopoulou et al.[37]	2022	Systematic	NS	9 studies	PROMs (preference)	More positive feelings were generally observed with the intraoral scanners regarding smell, taste, sound, vibration, nausea, and queasiness. Overall, comfort assessment mostly favoured digital methods. No differences were found concerning the level of anxiety between the two methods.
D'Ambrosio et al[38]	2023	Umbrella	NS	23 studies	accuracy, time , PROMs (preference)	The digital impression seems to be preferred over the analog one as regards time and patient preference. Data on accuracy is conflicted, especially regarding full-mouth rehabilitations
de Paris Matos et al.[39]	2023	Systematic and Meta-analysis	NS	11 studies	PROMs (preference, satisfaction)	Patients preferred intraoral scanning to conventional impression making. Discomfort, absence of nausea, absence of unpleasant taste, and absence of breathing difficulty were also significantly different.
Khan et al.[40]	2021	Systematic	NS	17 studies	accuracy, trueness, restoration accuracy, time	Digital impression showed the shorter time. It has many benefits over the regular impression method and improved accuracy.
Serrano-Velasco et al.[41]	2023	Systematic	mixed dentition	4 studies	PROMs (preference), time, accuracy	All studies agreed that the patient perception and comfort is better with intraoral scanners in comparison with the conventional method. The accuracy or reliability or time required of the digital procedure compared to conventional techniques are not clear.
Siqueira et al.[42]	2021	Systematic	partially edentulous, fully edentulous	17 studies	PROMS, time	IOS is faster than CI, independent of whether a quadrant or complete arch scan is conducted. IOS can improve the patient experience measured by overall preference and comfort and is able to provide reliable prosthodontic outcomes.
Sivaramakrishnan et al.[43]	2020	Network meta-analysis	NS	14 studies	PROMs (preference), time	There was an overall preference for digital impressions, although the time required is longer.
Srivastava et al.[44]	2023	Systematic	fully edentulous	12 studies	accuracy	Intraoral scanners can be used to digitize denture-bearing areas, but the interpretation of the peripheral border and the soft palate should be carefully carried out.

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