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SYSTEMATIC REVIEW

Enhancing scanning accuracy of digital implant scans: A systematic review on application methods of scan bodies

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ABSTRACT

Statement of problem. Scan bodies play a crucial role in the accuracy of digital implant scans by serving as implant-positioning transfer devices. Previous literature has demonstrated the effects of scan body characteristics on the accuracy of digital implant scans. However, the optimal application methods of scan bodies to enhance scanning accuracy remain unclear.

Purpose. The purpose of this systematic review was to determine the optimal application methods of scan bodies to enhance the accuracy of digital implant scans.

Material and methods. An electronic search was conducted by using the PubMed (MEDLINE), Web of Science, Cochrane Library, and Embase databases from November 2018 to 2023. Relevant references from the included studies were further screened manually for eligibility. Following the population, intervention, comparison, and outcome (PICO) criteria, a research question focused on identifying the optimal application method for effectively using scan bodies to enhance scanning accuracy was developed. Specific inclusion criteria involved in vitro and in vivo studies. The Checklist for Reporting In Vitro Studies (CRIS) guidelines were followed and the assessment of the risk of bias in the included studies was conducted.

Results. Sixteen articles that met the eligibility criteria were included in this systematic review. Two studies investigated the effect of scan body bevel orientation on the accuracy of digital implant scans, and 3 examined the impact of tightening torque on scan bodies. Among the studies focusing on completely edentulous arches, 5 recommended the use of auxiliary geometric devices on the dental arch to enhance scanning accuracy. However, 2 studies reported no improvements in accuracy after splinting scan bodies with thread.

Conclusions. Different techniques for applying scan bodies, such as configuring bevel orientation, adjusting tightening torque, and attaching auxiliary geometric devices, influence the accuracy of digital implant scans. For scanning completely edentulous arches, attaching auxiliary devices to scan bodies to cover the edentulous ridge effectively enhances scanning accuracy. (J Prosthet Dent xxxx;xxx:xxx-xxx)

Rapid advances in computer-aided design and computer-aided manufacturing (CAD-CAM) technologies have enabled the fabrication of implant-supported restorations with a digital workflow of direct or indirect data acquisition for dental implant scanning.[1] Indirect data acquisition uses an optical desktop scanner and

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Clinical Implications

This systematic review offers clinicians guidance on selecting optimal scan body application methods. It highlights the importance of considering both the bevel orientation and the selected tightening torque of scan bodies. For scanning completely edentulous arches, the use of auxiliary geometric devices that cover the dental arch is advised to improve scanning accuracy.

laboratory scan bodies to digitize conventional implant impressions. Direct data acquisition enables a fully digital workflow by using an intraoral scanner (IOS) and scan bodies to directly scan the dentition and implant positions in the oral cavity.[1,2] The precise geometry of the scan bodies is captured through direct data acquisition. Subsequently, the position, direction, and angulation of the implants are analyzed in a CAD software program.[2,3] The advantages of direct digital implant scans over conventional impressions include enhanced patient comfort and acceptance, a decreased risk of distorted impression material during its transfer to a laboratory, a decreased risk of disease transmission between patients and dental laboratory technicians, and reduced clinical time.[2,4]

Accuracy has been defined as a combination of trueness and precision.[5,6] Trueness refers to the extent to which the measurements deviate from the real dimensions of the measured object, while precision refers to the closeness of repeated measurements of the same object.[5,6] High trueness indicates high closeness between the measurements and the actual dimensions of the object being measured, while higher precision indicates high predictability, repeatability, and consistency of findings.[3,6,7] The accuracy of digital implant scans is substantially important as it significantly influences the outcome of dental implant restorations.[8–11] Imprecise transfer of the implant position from the oral cavity to a CAD software program can result in restoration misfit, potentially leading to biological and mechanical complications.[12] Factors that can affect the accuracy of digital implant scans include the type of IOS,[13–20] the scan body features and material,[9,21–23] the scanning strategy,[20] the implant position and angulation,[14,16,17,19,23–27] the interimplant distance,[14,16,17,19,26,27] and the operator experience.[28]

Scan bodies, serving as implant-positioning transfer devices, play a crucial role in the accuracy of digital implant scans.[15–19,26,27,29,30] Previous systematic reviews have reported the effects of the scan body characteristics on scanning accuracy, such as type of material, surface condition, and geometric shape.[31–33] However, there remains a substantial knowledge gap in understanding how specific application methods of the scan bodies influence the accuracy of digital implant scans. Therefore, the objective of this systematic review was to determine the optimal application methods of scan bodies to enhance the accuracy of digital implant scans. The null hypothesis was that the application methods of scan bodies would not affect the accuracy of digital implant scans.

MATERIAL AND METHODS

This systematic review was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[34] The protocol was registered under the International Prospective Register of Systematic Reviews (PROSPERO), CRD42023491557. Following the population, intervention, comparison, outcome (PICO) criteria, the following research question was formulated, "What is the optimal application method of scan bodies to enhance the scanning accuracy of digital implant scans?".

The inclusion criteria were in vitro and in vivo studies on digital implant scans with scan bodies. The exclusion criteria were case reports, expert opinions, literature reviews, animal studies, studies on 1-piece implants, studies solely focused on the characteristics of scan bodies (such as design and materials), and publications in languages other than English. An electronic search was independently conducted by 2 investigators (Q.W., N.H.M.M.H.) using the PubMed (MEDLINE), Web of Science, Cochrane Library, and Embase databases. Only articles published between November 2018 and 2023 were included. A manual search was further performed on the reference lists of all related articles obtained from the electronic search. The search terms for each database are presented in Table 1.

The articles from the databases were imported into the literature management software program (EndNote X20; Clarivate) to remove duplicates. Two reviewers (Q.W., N.H.M.M.H.) independently screened the titles and abstracts of the studies, and any discrepancies were resolved by a third reviewer (N.L.). If the abstract or title lacked sufficient details to justify inclusions, full-text articles were selected for screening. After full-text screening, data from articles meeting the inclusion criteria were extracted, and those meeting the exclusion criteria were excluded. The extracted data were recorded in a spreadsheet (Excel v2019; Microsoft Corp).

Risk of bias assessment for the included studies was conducted independently by 2 investigators (Q.W., N.H.M.M.H.) by following the Checklist for Reporting In Vitro Studies,[35] and any discrepancies were addressed by a third investigator (N.L.). The tool comprises 5 aspects: sample size calculation, sample preparation and

Table 1. Search strategy based on different databases

Database	Search Strategy
PubMed (MEDLINE), Web of Science, and Cochrane Library	((digital impression) OR (intraoral scan*) OR (digital dentistry)) AND (accuracy OR trueness OR precision) AND (scan body) AND (dental implant)
Embase	('digital impression' OR (digital AND ('impression'/exp OR impression)) OR 'intraoral scanner'/exp OR 'intraoral scanner' OR (intraoral AND ('scanner'/exp OR scanner)) OR 'digital dentistry' OR (digital AND ('dentistry'/exp OR dentistry))) AND ('accuracy'/exp OR accuracy) AND ('scan body' OR (scan AND ('body'/exp OR body))) AND ('dental implant'/exp OR 'dental implant' OR (('dental'/exp OR dental) AND ('implant'/exp OR implant))) AND [2018–2023]/py

handling, blinded assessment of the outcomes, statistical methods for data analyses, and a mention of limitations and potential risk of bias. Each aspect was evaluated with a response of “yes, no, or unclear.” For the overall risk of bias assessment, the study was classified based on the number of “yes” responses for each aspect. Studies with all “yes” responses were considered of high quality (low risk of bias), those with 3 or 4 “yes” responses were considered of medium quality (moderate risk), and articles with fewer than 3 “yes” responses were categorized as low quality (high-risk).

RESULTS

A total of 312 articles were initially identified based on the search strategies, and 172 duplicate studies were then removed. After abstract revision per the inclusion and exclusion criteria, 16 articles[13,14,16–22,25–30,33] were ultimately included in this systematic review (Fig. 1). Table 2 presents the characteristics of the included studies. One study[18] was performed in vivo, while the others[13,14,16,17,19–22,25–30,33] were in vitro studies. The 16 included studies were classified into 6 groups based on scan body application methods (Table 3): scan body bevel orientation (n=2),[20,25] tightening torque for scan bodies (n=3),[21,22,28] scan body splinting with thread (n=2),[14,33] scan body splinting with conventional resin-wire (n=1),[13] attaching auxiliary geometric devices passing over the dental arch (n=5),[17,19,26,27,30] and attaching auxiliary geometric devices passing over the buccal or lingual areas of the dental arch (n=3).[16,18,29]

Two included studies[20,25] analyzed the effect of scan body bevel orientation on scanning accuracy, and both reviewed the impact of scan body bevel orientation on scanning accuracy. Gomez-Polo et al[25] reported that

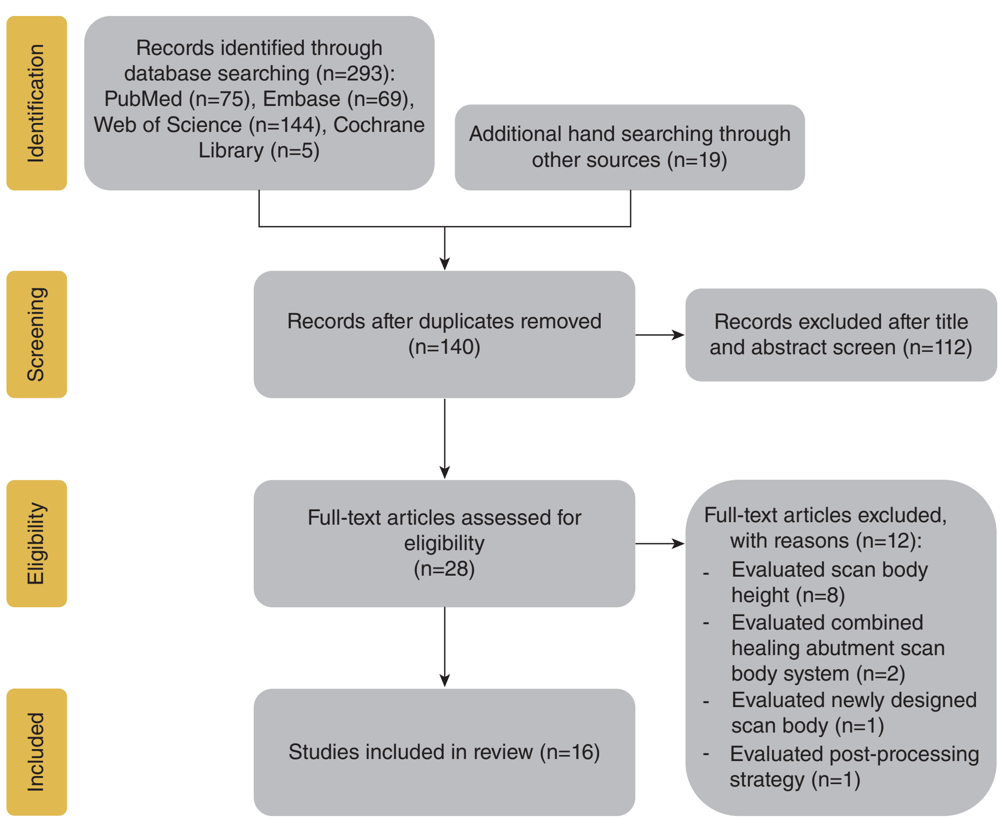

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram describing study selection.

Table 2. Characteristics of included studies

Author (Year)	Study Type	Dentition Status	Intraoral Scanning			Scan Body Manufacturer (Material)	Accuracy Parameters
			System	Powder Use	Operator		
Iturrate et al (2019a)[26]	In vitro	Completely edentulous maxilla	1) True Definition; 2) TRIOS 3; 3) iTero	Only for True Definition	Single specialist	N/S	Accuracy
Iturrate et al (2019b)[17]	In vitro	Completely edentulous maxilla	1) True Definition; 2) TRIOS 3; 3) iTero	Only for True Definition	Single specialist	N/S	Accuracy
Kim et al (2020)[22]	In vitro	Single edentulous site	Not used	No	Experienced prosthodontic resident	1) Straumann (PEEK); 2) Dentium (PEEK); 3) Myfit (PEEK); 4) Myfit (Ti-based)	Scan body displacement
Mizumoto et al (2020)[33]	In vitro	Completely edentulous maxilla	TRIOS	N/S	Single operator	1) Dentsply Sirona; 2) Nt-Trading GmbH & Co KG; 3) DESS-USA; 4) Core3Dcentres; 5) Zimmer Biomet Dental	Accuracy
Lee et al (2021)[20]	In vitro	Three single edentulous sites with adjacent teeth	1) CS3600; 2) TRIOS 3; 3) i500		N/S	Geomedi Co	Trueness
Garbacea et al (2022)[16]	In vitro	Completely edentulous maxilla	1) TRIOS 3; 2) True Definition	Only for True Definition	Experienced clinician	Nobel Biocare	Accuracy
Gómez-Polo et al (2022)[25]	In vitro	Completely edentulous maxilla	TRIOS 3	N/S	Experienced dentist	Avinent	Accuracy
Kernen et al (2022)[29]	In vitro	Completely edentulous maxilla	CS3600	No	Single operator	CAMLOG Biotechnologies GmbH	Accuracy
Pozzi et al (2022)[27]	In vitro	Completely edentulous mandible	TRIOS 3	No	Experienced operator	LaStruttura spa	Accuracy
Shi et al (2022)[28]	In vitro	Single edentulous site	TRIOS 3	N/S	(1) Scan body placement: 1) Two non-dentists 2) Two dentists without restorative implant experience 3) Two dentists with restorative implant experience (2) Scan procedure: Experienced operator	Dentsply Sirona (Ti-based)	Scan body displacement
Azevedo et al (2023)[13]	In vitro	Completely edentulous mandible	1) iTero Element 5D; 2) TRIOS 4; 3) Primescan; 4) i700; 5) Virtuo Vivo	No	Experienced operator	Zirkonzahn GmbH	Trueness
Denneulin et al (2023)[14]	In vitro	Completely edentulous mandible	1) TRIOS 3; 2) Primescan	No	N/S	Dentsply Sirona	Accuracy
Diker et al (2023)[21]	In vitro	Single edentulous site	Not used	No	N/S	1) Zfx-dental GmbH (PEEK) 2) Medentica (Ti)	Scan body displacement
Kernen et al (2023)[18]	In vivo	Completely edentulous maxilla and mandible	1) CS3600; 2) TRIOS 3	No	Two experienced and calibrated dentists	N/S	Accuracy
Retana et al (2023)[19]	In vitro	Completely edentulous mandible	1) Primescan; 2) Omnicam; 3) TRIOS 4; 4) TRIOS 3; 5) Emerald; 6) i500; 7) CS3600	No	Experienced operator	MIS Implant Technologies	Trueness
Wu et al (2023)[30]	In vitro	Completely edentulous maxilla	Aoralscan3	No	Experienced operator	ELOS MEDTECH	Accuracy

N/S, not stated; PEEK, polyetheretherketone; Ti, titanium

Table 3. Accuracy outcomes following various scan body applications

Classification	Author (Year)	Scan Body Application Methods	Main Outcomes
Bevel orientation	Lee et al (2021)[20]	Orientation of scan body flat surface toward buccal or proximal surface	Higher trueness for buccal orientation of bevel than proximal orientation
	Gómez-Polo et al (2022)[25]	Orientation of scan body bevel geometry toward facial, mesial, distal, lingual, or random surfaces	Higher accuracy for lingual orientation of bevel
Tightening torque	Kim et al (2020)[22]	Tightening torque with 5, 10 Ncm, and hand tightening	Vertical displacements of PEEK-based scan bodies remained below clinically acceptable threshold at tightening torques of 5 and 10 Ncm.
	Shi et al (2022)[28]	Tightening torque with 15, 20, 25, 30, and 35 Ncm by 6 operators with three manipulator levels	Deviation levels did not surpass occlusal threshold previously established.
	Diker et al (2023)[21]	Tightening torque with 10 and 15 Ncm	To minimize displacement in 1-piece PEEK scan bodies, consider using 10 Ncm or lower torque application.
Splinting – thread	Mizumoto et al (2020)[33]	Splinting scan bodies with floss	Significantly greater distance deviation when using floss as splinting device compared to no splinting
	Denneulin et al (2023)[14]	Splinting scan bodies with blue suture thread (Novosyn, BBraun Surgical)	Splinting implants led to reduced accuracy
Splinting – conventional resin-wire	Azevedo et al (2023)[13]	Splinting scan bodies with orthodontic wire and light-polymerized resin	Splinting scan bodies improved accuracy in TRIOS 4, but did not affect results with other devices
Attaching auxiliary geometric devices – passing over dental arch	Iturrate et al (2019a)[26]	Attaching device with gaps filled to mimic natural tooth anatomy	Improved scanning accuracy of complete arch scan when using device
	Iturrate et al (2019b)[17]	Attaching device with gaps filled to mimic natural tooth anatomy	Improved scanning accuracy of complete arch scan when using device
	Pozzi et al (2022)[27]	Attaching device with modular chains and detailed opaque surfaces	Improved scanning accuracy of complete arch scan when using device
	Retana et al (2023)[19]	Attaching splinting bars with square cross-section of 5×5 mm and random textures on one side	Improved scanning accuracy of complete arch scan when using device
	Wu et al (2023)[30]	Attaching device consisting of 1 portion and 2 extended structures with curved or flat surfaces, attached at 2 levels: adjacent to and away from mucosa	Improved scanning accuracy of complete arch scan when using device. Better accuracy with flat surface device adjacent to mucosa
Attaching auxiliary geometric devices – passing over buccal or lingual areas of dental arch	Garbacea et al (2022)[16]	Attaching device with natural tooth geometry landmarks outside dental arch	Accuracy significantly decreased for measurements across arch midline
	Kernen et al (2022)[29]	Attaching device passing over lingual side of dental arch, available in various materials (dental model resin, flexible resin, white resin) and patterns (circular, square, irregular)	Improved scanning accuracy of complete arch scan when using device with irregular design and dental model resin, compared with non-using
	Kernen et al (2023)[18]	Attaching device passing over lingual side of dental arch	The device reduced linear deviation in CS3600 group compared to no device, but not in TRIOS 3 group

IOS, Intraoral scanner; Ncm, Newton centimeters; PEEK, polyetheretherketone; Ti, titanium

turning the scan body bevel orientation toward the lingual surface resulted in higher accuracy for a complete arch edentulous scan compared with the other orientations, while Lee et al[20] reported higher trueness when the flat surfaces of the scan bodies were oriented buccally for a dental arch with a single implant involving adjacent teeth. Both studies showed decreased accuracy when the bevel was oriented proximally.[20,25]

In single-tooth implants, scan body displacement generally increased with higher torque values.[21,22,28] Tightening torques varied among studies, with values of 5,[22] 10,[21,22] 15,[21,28] 20,[28] 25,[28] 30,[28] and 35 Ncm,[28] including a study using hand tightening.[22] With the same applied torque values, greater displacement was reported when using polyetheretherketone (PEEK) scan bodies than those with titanium connections.[21,22] Applying a torque of 10 Ncm or lower was recommended to maintain the displacement of 1-piece PEEK scan bodies within clinically acceptable levels.[21,22]

Studies focusing on splinting with thread revealed that using floss or blue suture thread increased distance deviation or reduced accuracy.[14,33] Meanwhile, studies on splinting with conventional resin-wire noted improved accuracy only in a specific device.[13] Studies on attaching auxiliary geometric devices over the dental arch consistently reported improved scanning accuracy of complete arch scans when using devices designed to mimic natural tooth anatomy[17,26] or incorporating specific features like modular chains,[27] textured splinting bars,[19] and scan body clasps.[30] In contrast, when devices were used over the buccal or lingual areas of the dental arch, results varied.[16,18,29] One study reported a significant decrease in accuracy for measurements across the arch midline,[16] while others reported improved

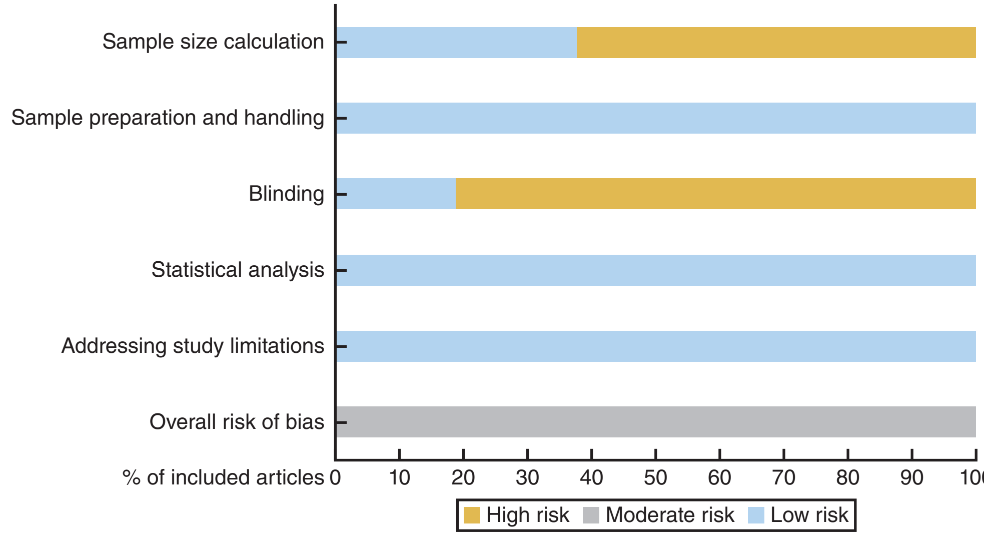

Figure 2. Qualitative analysis by using Checklist for Reporting In Vitro Studies guidelines.

accuracy with devices made of different materials and patterns,[18,29] although enhancements were device-specific in terms of reducing linear deviations.[18]

All included articles possessed a moderate risk of bias when considering overall aspects (Fig. 2). When examining individual aspects, a high risk of bias was identified in 62.5% of the included studies because of the absence of sample size calculation and in 81.25% because of unreported blinding between those providing interventions and those assessing outcomes of interest. A detailed risk of bias assessment for each study is presented in Supplemental Table 1 (available online).

DISCUSSION

This systematic review demonstrated that scan body application methods significantly influence the accuracy of digital implant scans. These methods included scan body bevel orientation and tightening torque adjustments for connecting the scan bodies with implants, as well as the use of auxiliary geometric devices in completely edentulous arches. Therefore, the null hypothesis that the application methods of scan bodies would not affect the accuracy of digital implant scans was rejected.

The orientation of the scan body bevel is a critical factor to consider during digital implant scanning, as it impacts scanning accuracy.[20,25] Two included studies on multiple edentulous sites with adjacent teeth[20] and a completely edentulous arch[25] supported increased scanning accuracy when the flat surface of the scan body was turned toward the buccal and lingual sides, respectively. Turning the scan body bevel toward proximal directions could lead to more errors because adjacent structures often include undercuts or deep, sharp, inclined, or overcrowded surfaces that are difficult to capture.[20] These surfaces can result in defects in the definitive 3-dimensional images, thereby affecting the accuracy of measurements of adjacent structures.[5] Nevertheless, comprehensive scanning of the entire scan body is crucial to minimize defects in scanned images of the scan body surfaces and ensure more accurate implant positioning in a CAD software program, with a recommended scan body surface defect below 10%.[36] While studies on the effect of scan body bevel orientation on scanning accuracy have been limited, available research consistently shows that scan accuracy decreases when the bevel is oriented toward the proximal surfaces.[20,25]

Tightening torque for the scan body was found to be a key factor influencing scan body displacement,[21,22,28] with studies indicating that higher tightening torque values led to greater displacement of components, likely because of the settling effect at the implant connection, potentially caused by material deformation.[9,37] The different features and materials of the scan body base, particularly in relation to titanium dental implants, may contribute to this effect.[9,21,22] The studies analyzed in this systematic review revealed conflicting results based on whether scan body connections were made of PEEK or titanium.[21,22,28] The study using titanium-based scan bodies applied torques of 20 to 35 Ncm without exceeding occlusal thresholds.[28] Conversely, the studies with PEEK-based scan bodies reported significantly greater displacements compared with Ti-based, suggesting a torque of 10 Ncm or less to maintain clinical tolerance.[21,22] It should be noted that the scan bodies came from various manufacturers, and some did not specify a recommended torque, contributing to inconsistencies.

Making digital scans of a completely edentulous arch is challenging because of insufficient anatomic landmarks between scan bodies for stitching intraoral features during the digital intraoral scanning procedure.[13] The present systematic review highlights that the use of auxiliary geometric devices is beneficial for improving the scanning accuracy of a completely edentulous arch.[17,19,26,27,30] The scanning device serves as an optical bridge or trackable scanning route by providing adequate surface morphology for the IOS, enhancing the scanning accuracy by improving the stitching process in the edentulous area between multiple implants.[27,29] However, 2 included studies,[14,33] both using thread for scan body splinting, concluded that scanning accuracy worsened. The inconsistency in results could be explained by the different thicknesses and flexibility of the materials used to cover the edentulous areas.[14,33] Another study used conventional direct resin applied on an orthodontic wire, which reported varying results depending on the device used.[13] This variability may stem from the manual fabrication process, which may lack the geometric features needed for effective stitching.[13] Although a consensus on a definite auxiliary geometric design is lacking, the scanning device for complete arch digital implant scans should consider chairside attachment, minimal contact areas to scan the body with no soft tissue interference, optimal surface geometric texture, and variable adaptation to scanning distance according to the distance between implants.[29,30] The geometry should not be excessively intricate, with substantial curvature or concealed surfaces, as complexity can impede the scanning process.[30] Furthermore, studies on devices designed to traverse the buccal or lingual areas of the dental arch, rather than covering the dental arch, reported inconsistent improvements.[6,18,29] This inconsistency is likely due to the scanning strategy requiring the device to pass outside the arch, which can lead to drawbacks.[6,18,29] Therefore, designing auxiliary geometric devices to connect scan bodies and cover the dental arch may be advantageous for scan accuracy.[17,19,26,27,30]

The accuracy of a scan body splinting device for complete arch implant digital scans may also be influenced by factors that include the IOS system,[13–19] implant position, and implant angulation.[14,16,17,19,24–27] Different outcomes of IOS systems could be attributed to different scanning head sizes,[13,15] stitching algorithms, or data acquisition technologies,[3,8,15,16,19] with a larger scanning head enhancing accuracy by capturing a wider area.[13,15] Positive effects of splinting devices on the position of angled implants, compared with those of straight implants, have been reported.[16,27] Additionally, scanning errors may increase with longer interimplant distances.[14,16,17,19,26,27] Nevertheless, Arcuri et al[24] reported that angular deviation during implant scanning was not influenced by implant angulation but rather by its position in the dental arch. Implants positioned in the transition zone between hemiarches exhibited the highest deviation because of critical IOS handling maneuvers of the operator.[24] To minimize scanning errors from certain implant angulations and positions, auxiliary geometric devices passing over the dental arch are recommended to ensure the proper fit of complete arch dental prostheses.[17,19,26,27,30]

The findings from this systematic review suggest clinical guidelines that include avoiding positioning the scan body bevel toward the proximal tooth.[20,25] For scan bodies with PEEK bases, controlling the tightening torque to 10 Ncm or less is recommended to prevent excessive displacement that overtightening might cause.[21,22,28] For completely edentulous arches, attaching auxiliary geometric devices between implants can enhance accuracy, especially when the gap between implants is large.[17,19,26,27,30] However, attaching these devices to traverse the buccal or lingual sides of the arch or splinting scan bodies with thread may not be beneficial.[14,16,18,29,33] Because of the limited data on bevel orientation and tightening torque, further studies are needed to establish definitive clinical guidelines.

Limitations of the present systematic review included that a meta-analysis could not be performed because of heterogeneity among the included studies, such as variations in methodologies for determining outcomes of interest, dentitional status, IOS systems, as well as scan body designs and materials.[23] The findings —predominantly acquired from in vitro studies—may underestimate scanning errors in a real patient's oral cavity because of factors like saliva and tongue movement that hinder the image stitching process.[27] Furthermore, the individuals conducting the scans were primarily experienced practitioners, which means the findings may not be applicable to less experienced individuals.[28] Further research on factors influencing scanning quality, such as ambient light and operator experience, is necessary. Clinical research is needed to improve the generalizability of the findings and to establish clinical decision-making guidelines for accurate digital implant scans using scan bodies.

CONCLUSIONS

Based on the findings of this systematic review, the following conclusions were drawn:

1. The accuracy of digital implant scans is influenced by the application methods of scan bodies, which include factors such as scan body bevel orientation, tightening torque, and the use of auxiliary geometric devices.
2. For optimal implant scans, it is advantageous to ensure that the bevel of scan bodies does not face proximally when mounted. A torque of 10 Ncm or lower is beneficial for PEEK-based scan bodies to minimize displacement. Additionally, attaching auxiliary geometric devices over the dental arch to scan bodies in completely edentulous arches may enhance scan accuracy. However, because of limited data, further studies are required to establish definitive clinical guidelines.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

APPENDIX A. SUPPORTING INFORMATION

Supplemental data associated with this article can be found in the online version at doi:10.1016/j.prosdent.2024.06.010.

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