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SYSTEMATIC REVIEW

Trueness of complete arch intraoral implant scans using splinted and non-splinted scan bodies: A systematic review and meta-analysis

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ABSTRACT

Statement of problem. Although splinting implant scan bodies has been proposed as a strategy to enhance the accuracy of complete arch intraoral implant scans, its effect on trueness has not been systematically investigated.

Purpose. The purpose of this systematic review and meta-analysis was to evaluate the effect of splinted versus non-splinted implant scan body configurations on the trueness of complete arch intraoral implant scans.

Material and methods. This systematic review and meta-analysis was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and structured according to the Participant, Intervention, Comparison, and Outcome (PICO) framework. Electronic searches were performed in the Web of Science, Scopus, and PubMed databases for studies published between January 2015 and December 2025. Quantitative outcomes related to trueness, including linear deviation, angular deviation, and root mean square (RMS) deviation, were extracted. Meta-analyses were performed using a random-effects model with standardized mean differences (SMDs) and 95% confidence intervals (CIs).

Results. Eight studies were included in the meta-analysis. Splinting implant scan bodies demonstrated a statistically significant effect on trueness for linear deviation (SMD=0.49; 95% CI: 0.11 to 0.88; *P*=.016). No statistically significant differences were observed between splinted and non-splinted techniques for angular deviation or RMS deviation (*P*>.05). Moderate to high heterogeneity was identified across outcomes, and scanner-specific performance characteristics were found to contribute to variability among studies.

Conclusions. Splinting implant scan bodies significantly improved trueness in terms of linear deviation for complete arch intraoral implant scans. However, no consistent benefits were observed for angular deviation or RMS deviation. (J Prosthet Dent xxxx;xxx:xxx-xxx)

The accuracy of complete arch intraoral implant scans used for the fabrication of implant-supported fixed dental prostheses remains a subject of debate.[1–4] This uncertainty has been primarily attributed to the limited number of available reference points and the absence of anatomical irregularities in edentulous arches, which may compromise the stitching process and spatial accuracy of intraoral scanning.[5,6]

Precise documentation of the 3-dimensional spatial configuration of dental implants is essential to ensure the passive fit of implant-supported restorations, a critical determinant of long-term biological and mechanical success.[7–9] In digital workflows, intraoral scanners (IOSs) generate datasets in the form of standard tessellation language (STL) files, which are subsequently used for the fabrication of interim or definitive implant-supported prostheses.[10]

The accuracy of intraoral digital scans is highly dependent on operator-related factors,[11] including the choice of scanning technology and system; scanner head dimensions; calibration procedures; scanning distance;

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Clinical Implications

Splinting implant scan bodies may be associated with improved linear accuracy during complete-arch intraoral implant scanning and may be considered in situations involving large inter-implant distances or when increased positional stability is desired. However, given the absence of statistically significant differences in angular and RMS deviations, clinicians should cautiously balance the additional clinical time and procedural complexity associated with splinting against its potential benefits and consider scanner-specific performance characteristics when selecting scanning protocols.

exposure of the IOS to environmental variables such as temperature, humidity, and lighting conditions; as well as operator experience, scanning strategy, scan extent, and the use of corrective techniques such as trimming, rescanning, and overlapping.[11] A systematic assessment of patient-specific intraoral conditions and an understanding of factors that may influence scan accuracy are therefore fundamental to improving the predictability and reliability of digital implant scanning procedures.[12]

Material and design-related characteristics of implant scan bodies (ISBs) also affect scanning accuracy. Polyetheretherketone (PEEK) ISBs have been reported to have greater positional displacement compared with metal scan bodies.[13–15] In addition, the selected scanning strategy for complete arch implant recordings plays a critical role in determining the accuracy of the implant positions.[16–20] Implant-related factors, including inter-implant distance, implant angulation, and insertion depth, have been identified as variables that may negatively influence intraoral scanning accuracy.[12,21–24]

The characteristics of splinting techniques applied to ISBs further contribute to scanning accuracy.[25] The geometry and pigmentation of non-calibrated splinting structures may influence IOS precision, with irregular surface textures and beige coloration demonstrating improved trueness.[25] Moreover, the vertical positioning of splinted ISBs significantly affects scan accuracy; splinted ISBs positioned closer to the mucosal surface have been associated with increased trueness, whereas flatter morphologies have been linked to improved precision.[26]

Revilla-León et al[16] categorized implant scanning techniques into non-splinted ISBs, non-calibrated splinted ISBs, calibrated ISBs, calibrated frameworks, and reverse impression techniques.[16] Although splinting implant ISBs has been proposed as a strategy to enhance the accuracy of intraoral digital implant scans, the limited number of available studies precludes the formulation of definitive conclusions.[27] Moreover, it remains unclear whether the statistically significant differences in trueness reported between splinted and non-splinted implant scan body configurations result in clinically meaningful improvements in the performance and outcomes of implant-supported prostheses.[27]

The accuracy of a digital measurement is typically assessed by superimposing experimental and reference scans using a reverse-engineering software program, followed by the calculation of arithmetic means, positive and negative deviations, absolute deviations, and root mean square (RMS) values.[6] In quantitative analyses, when positive and negative deviations are evenly distributed, their cumulative sum is expected to approach zero.[6] Trueness has been commonly defined as the mean linear and angular deviation between a reference dataset and the corresponding experimental digital scans.[28,29]

Therefore, the objective of the present systematic review and meta-analysis was to evaluate the trueness of complete arch intraoral implant scans by comparing splinted and non-splinted implant scan body configurations, assessed in terms of linear deviation, angular deviation, and RMS deviation. The null hypothesis was that no statistically significant differences would be observed between splinted and non-splinted ISB techniques.

MATERIAL AND METHODS

The present systematic review and meta-analysis was designed according to the Population, Intervention, Comparison, and Outcome (PICO) framework and conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[30] In the PICO framework, P comprised edentulous or partially edentulous arches rehabilitated with complete arch implant-supported restorations, evaluated in both in vitro models and clinical settings. I consisted of complete arch intraoral implant scanning performed using splinted ISB, C involved complete arch intraoral implant scanning using non-splinted ISB, and the primary O was the trueness of implant position transfer, assessed quantitatively through linear deviation, angular deviation, and RMS deviation. A comprehensive literature search was independently performed by 2 reviewers (O.A., M.H.) across the Web of Science, Scopus, and PubMed databases. Any disagreements during the screening or selection process were resolved through discussion, and when consensus could not be reached, a third reviewer (Z.Y.D.) was consulted. The search covered studies published between January 2015 and December 2025. Database-specific adaptations of the search strategy are provided in Supplemental Table 1 (Available Online),

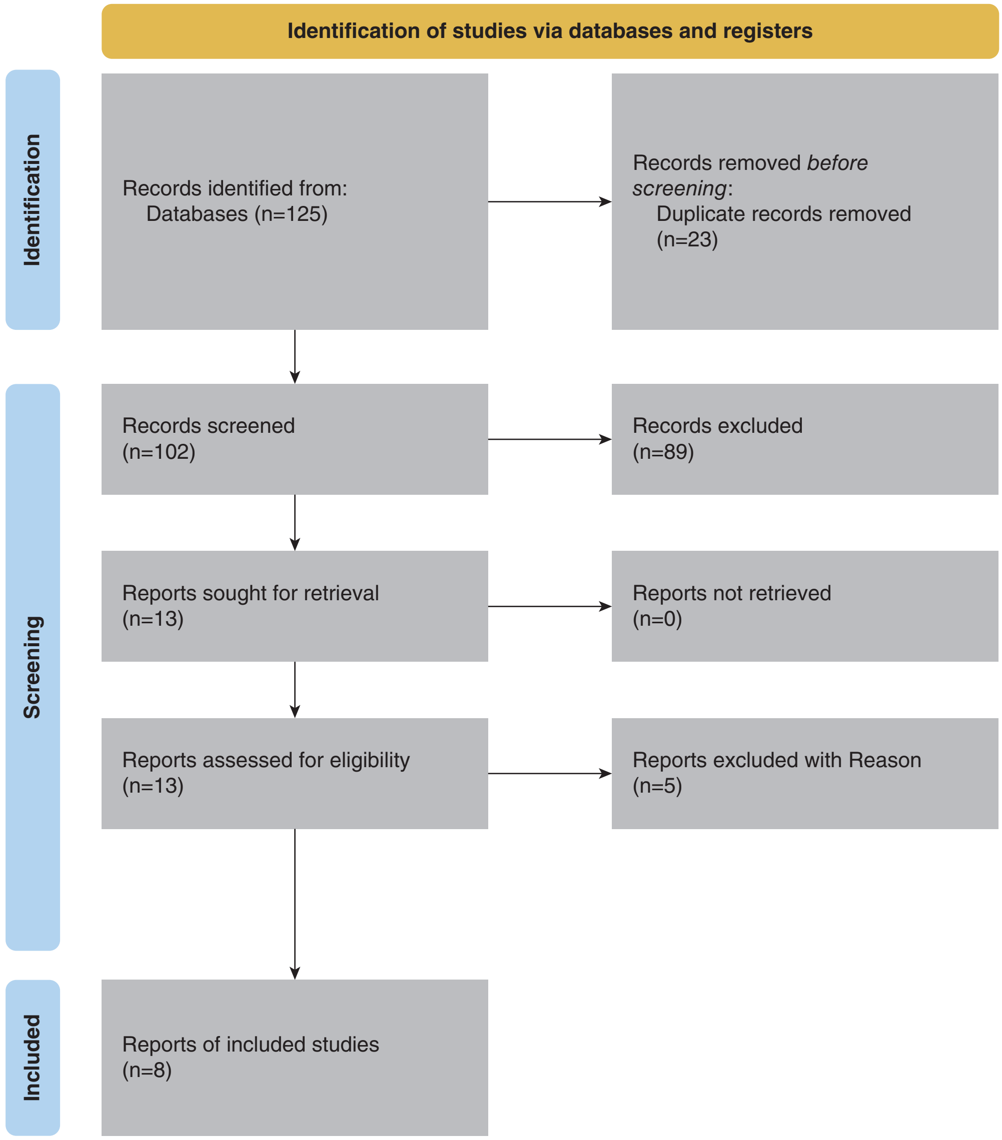

Figure 1. PRISMA flow diagram of study selection process.

and the study selection process is illustrated using a PRISMA flow diagram (Fig. 1).

The inclusion criteria encompassed clinical studies, including randomized and non-randomized controlled trials, as well as prospective and retrospective cohort studies, in addition to in vitro comparative investigations demonstrating adequate methodological rigor. Eligible studies were required to evaluate ISBs using splinted and non-splinted techniques within an implant-supported prosthodontic context and to report quantitative accuracy-related outcomes. Specifically, studies had to assess trueness or accuracy using validated metrics such as RMS deviation, linear deviation, or angular deviation based on reliable reference standards and appropriate superimposition methods. Only full-text articles published in English were considered eligible. Studies were excluded for inappropriate design, lack of implant scan body comparison, missing quantitative accuracy outcomes, insufficient methodology, non-validated measurements, animal studies, or non-English language, and inaccessible full text.

For studies reporting outcomes as medians with interquartile ranges (IQRs) or ranges, conversion to means and standard deviations (SDs) was performed using the method described by Wan et al[31] when implant-level measurements were reported separately within a study, means and SDs were statistically pooled to obtain a single study-level estimate in accordance with the Cochrane Handbook for Systematic Reviews of Interventions recommendations.[32]

When individual studies reported multiple scanner-specific outcomes derived from the same reference model, a single summary effect size per outcome was required to avoid unit-of-analysis errors. In such cases,

Table 1. Summary of included studies evaluating the effect of splinted and non-splinted ISBs on the trueness of complete arch digital implant scans

Author (Year)	Aim of the Study	Scan Body Material	Splint Material	Main Results	Risk of Bias
Revilla-León et al[4]	Compare accuracy of complete arch implant scans obtained with splinted and non-splinted ISBs using IOSs laboratory scanner and photogrammetry	Non-engaging scan abutments IPD Dental Group Barcelona Spain	Acrylic pattern resin	Digitization method and scan body configuration significantly affected trueness and precision. Non-splinted IOS scans showed lowest linear trueness.	Low
Bader Eddin and Önöral[8]	Compare trueness of multisite implant scans using different IOS protocols including splinted ISBs and auxiliary scan aids	Conventional ISBs NucleOSS Dental Implant Company	Pattern resin; composite resin; 3D-printed auxiliary devices	Splinting ISBs or using scan aids significantly improved trueness of digital implant scans.	Medium
Cheng et al[34]	Evaluate 3-dimensional linear and angular discrepancies of 4 scanning techniques including IOS with and without ISB splinting in maxillary edentulous model	Titanium ISB	Not specified	Splinting slightly reduced deviations at beginning of the scanning path but did not result in overall improvement in IOS accuracy.	Medium
Ashraf et al[6]	Assess effect of ISB splinting on accuracy of complete arch implant scans with different implant angulations	3-dimensional printed resin ISB	Modular chain device with composite fixation	Implant angulation did not significantly affect accuracy. ISB splinting positively influenced complete arch scan accuracy.	Medium
Azevedo et al[35]	Analyze effect of ISB splinting and auxiliary landmarks on trueness of complete arch implant scans using multiple IOSs	PEEK ISB	Orthodontic wire and light-polymerized resin	Splinting improved trueness only for TRIOS 4. No significant effect observed with other IOS systems.	Low
Nedelcu et al[36]	Evaluate in vivo reference acquisition method and assess trueness of different IOS acquisition protocols for complete arch implant scans	Not reported	Dental floss; bis-acrylic composite	Control protocol showed highest accuracy. Splinting techniques did not outperform optimized control scanning strategy.	Low
Retana et al[37]	Evaluate trueness of complete arch digital scans obtained with different IOSs with and without ISB splinting	Conical connection ISB	Not specified	Splinting significantly improved trueness regardless of IOS type. IOS system significantly influenced accuracy.	Low
Pozzi et al[38]	Assess accuracy of complete arch digital implant scanning s with and without ISB splinting	PEEK ISB	Thermoplastic resin; dental floss	ISB splinting significantly improved accuracy, particularly reducing linear and angular deviations at posterior implant sites.	Low

IOS, intraoral scanner; ISB, implant scan body; PEEK, polyetheretherketone.

the median value was selected as a pragmatic approach to prevent disproportionate weighting of individual studies in the pooled analysis.[9] Statistical analysis was conducted using a software program (JASP; version 0.95.4; JASP Team, University of Amsterdam) (α=.05). A random-effects model with SMDs (95% CI) was used;

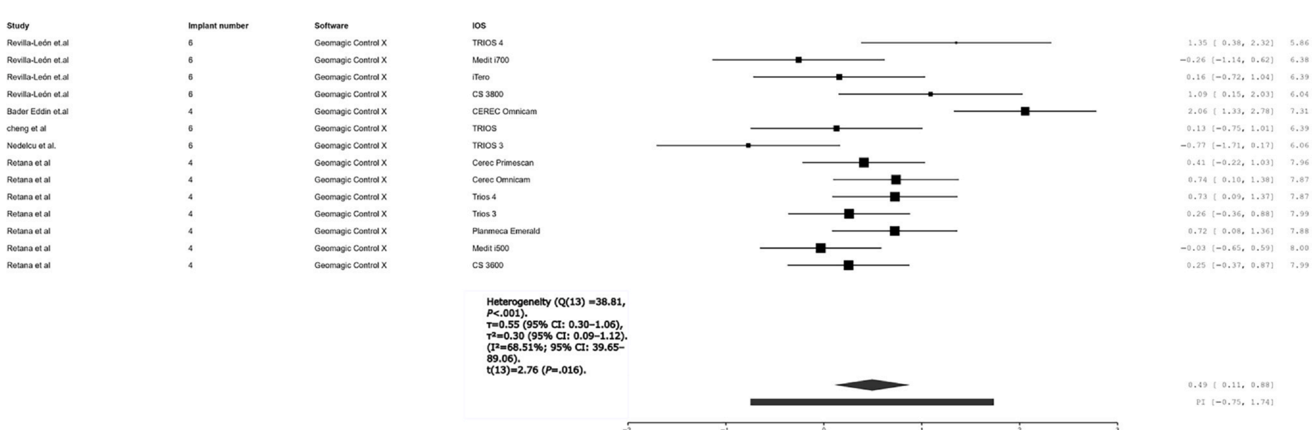

Figure 2. Forest plot illustrating pooled standardized mean difference for linear deviation between splinted and non-splinted scan body techniques using a random-effects model (positive standardized mean difference (SMD>0) favors the splinted technique, indicating reduction in linear error and higher positional accuracy.).

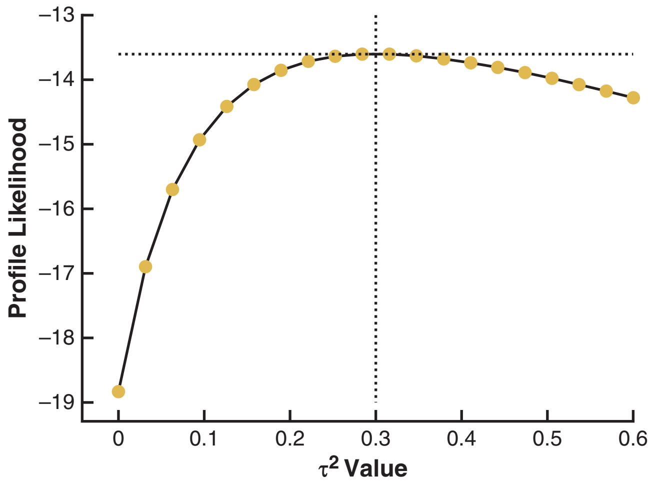

Figure 3. Profile likelihood plot for between-study variance (τ^2) demonstrating unimodal distribution with well-defined maximum likelihood estimate.

heterogeneity was assessed via I^2, and publication bias via the Egger test.

The risk of bias for included studies was assessed using the Quality Assessment Tool for In Vitro Studies (QUIN).[33] The risk of bias of the included in studies was independently assessed by 2 reviewers (O.A., M.H.) using the QUIN. Any disagreements were resolved through discussion and consensus. The certainty of the evidence was evaluated using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework via a software program (GRADEpro GDT; McMaster University and Evidence Prime Inc).

RESULTS

Inter-reviewer agreement was substantial for title screening (κ=0.79) and risk-of-bias assessment (κ=0.76) and moderate for abstract (κ=0.58) and full-text screening (κ=0.49). In total, 8 studies met the eligibility criteria and were included in the meta-analysis (Table 1). Five studies were excluded after full-text assessment, with the reasons for exclusion detailed in Supplemental Table 2 (Available Online).The risk of bias assessment for the included studies is summarized in Table 1, while the detailed domain level scoring is provided in Supplemental Table 3 (Available Online).

For linear deviation, the random-effects meta-analysis demonstrated a moderate pooled effect size of 0.49

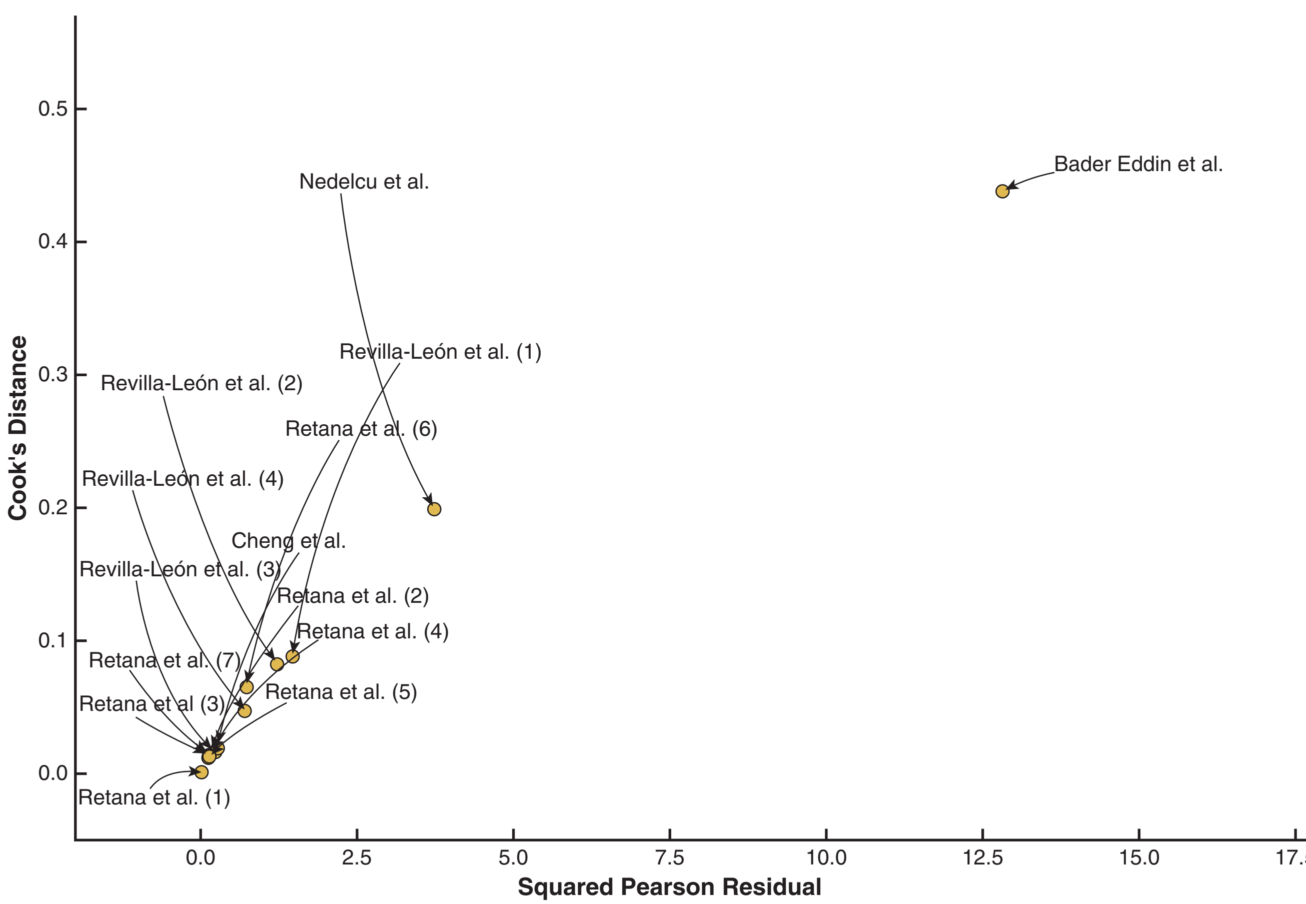

Figure 4. Baujat plot identifying individual study contributions to overall heterogeneity and pooled effect size, highlighting influential studies.

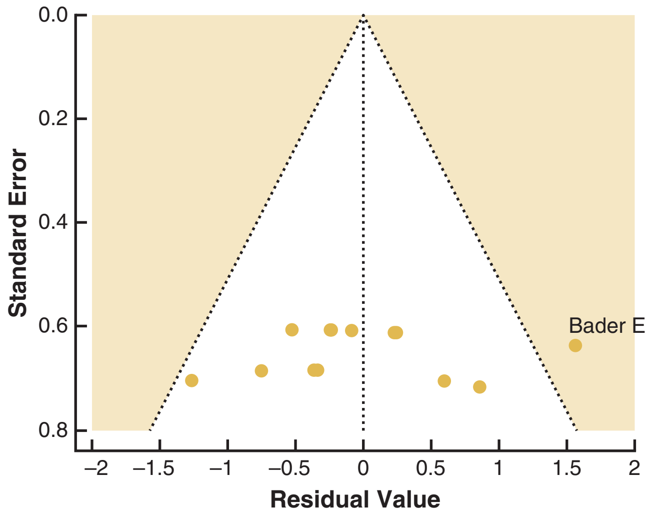

Figure 5. Residual funnel plot assessing asymmetry and study-level residuals in meta-analysis of linear deviation.

(95% CI: 0.11 to 0.88). The overall effect was statistically significant (P=.016), indicating a meaningful difference between splinted and non-splinted ISB techniques. However, substantial heterogeneity was observed among the included studies (Q(df=13)=38.81, P<.001). The estimated between-study variance was τ^2=0.30 (95% CI: 0.09 to 1.12), and the I^2 statistic was 68.51%, reflecting moderate to high inconsistency across studies (Fig. 2).

The profile likelihood plot for τ^2 revealed a clear unimodal distribution with a peak at τ^2=0.30 (Fig. 3). Influence diagnostics, including the Baujat plot and the residual funnel plot (Figs. 4, 5), in conjunction with the casewise diagnostics (Supplemental Table 4, Available Online), identified Bader Eddin et al[8] as a statistically influential outlier. This study exhibited a high standardized residual (3.58) and the largest Cook distance (0.438) among all included studies. Sensitivity analysis showed that exclusion of this study would markedly reduce heterogeneity, with the residual Q statistic decreasing to 19.85 and the between-study variance decreasing to τ^2=0.067.

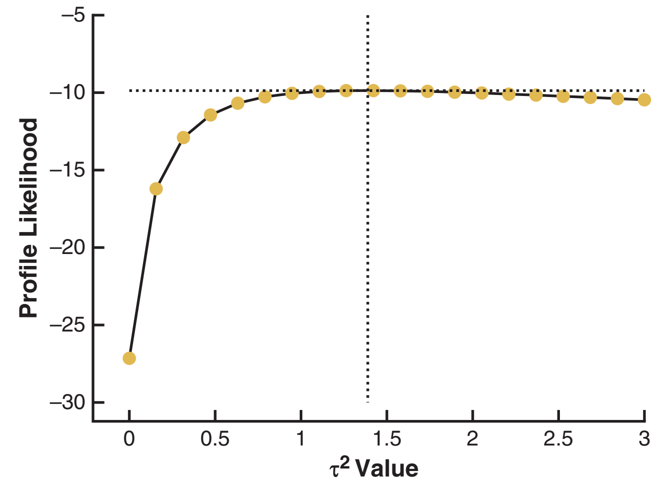

Figure 7. Profile likelihood plot for between-study variance (τ^2) in meta-analysis of angular deviation.

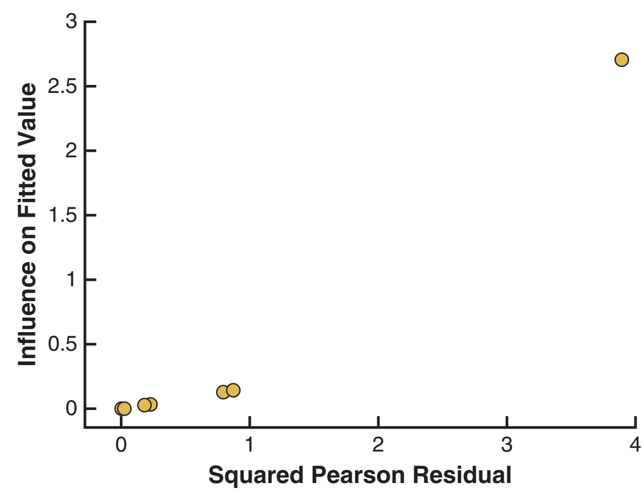

Figure 8. Baujat plot illustrating individual study contributions to overall heterogeneity and pooled effect size in angular deviation analysis.

For angular deviation, the random-effects meta-analysis yielded a pooled effect size of 0.22 (95% CI: −0.94 to 1.38). The overall effect was not statistically significant

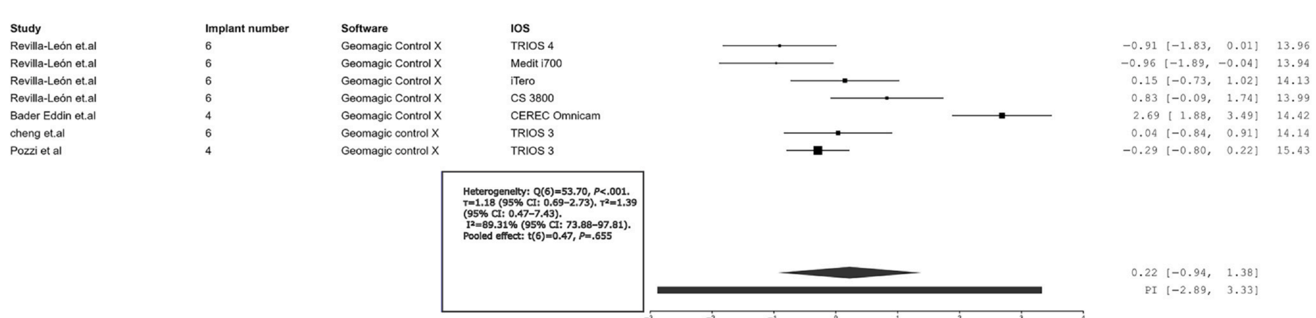

Figure 6. Forest plot of pooled standardized mean difference for angular deviation between splinted and non-splinted scan body techniques using random-effects model (positive values (SMD>0) favor the splinted technique (lower angular error)).

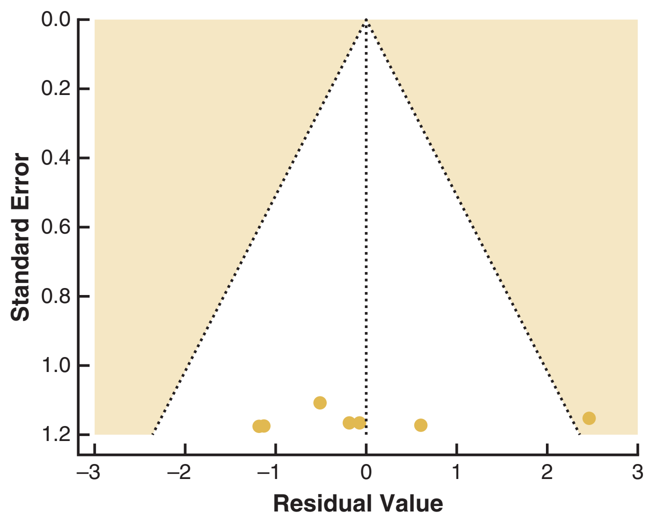

Figure 9. Residual funnel plot assessing study-level residuals and identifying influential outliers in angular deviation meta-analysis.

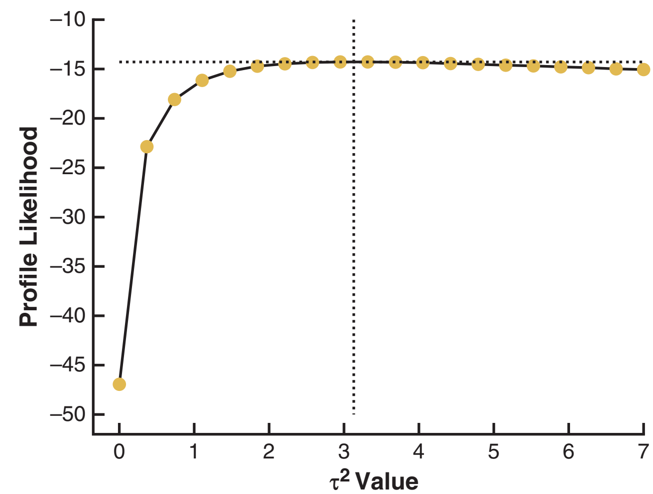

Figure 11. Profile likelihood plot for between-study variance (τ^2) in RMS deviation meta-analysis.

(*P*=.655). The 95% prediction interval ranged from −2.89 to 3.33. Substantial and statistically significant heterogeneity was observed across the included studies (Q (df=6)=53.70, *P*<.001). The I^2 statistic was 89.31% (95% CI: 73.88 to 97.81), indicating that the majority of the observed variability was attributable to true between-study differences rather than random sampling error (Fig. 6). The between-study variance was estimated at τ^2=1.39, reflecting a high level of heterogeneity.

The profile likelihood plot for τ^2 demonstrated a distinct peak at approximately 1.4 (Fig. 7). Influence diagnostics, including the Baujat plot and casewise diagnostics (Supplemental Table 5, Available Online), identified Bader Eddin et al[8] as a highly influential outlier (Fig. 8). This study exhibited a standardized residual of 4.339 and a Cook distance of 0.774, exceeding the corresponding values of all other included studies. The leave-one-out sensitivity analysis showed that removal of this study would substantially reduce heterogeneity, with the Qe decreasing to 10.72 and the τ^2 decreasing to 0.207. These findings were further supported by the residual funnel plot, in which the Bader Eddin et al[8] study lay well outside the 95% confidence limits, reinforcing its disproportionate influence on the pooled estimates (Fig. 9).

The random-effects meta-analysis of RMS deviation yielded a pooled effect size of 0.12 (95% CI: −1.41 to 1.65). The overall test for the pooled effect indicated no statistically significant difference between the compared groups (t(7)=0.18, *P*=.861). The prediction interval was wide (−4.34 to 4.57). (Q(df=7)=92.43, *P*<.001), with an I^2 value of 95.00% (95% CI: 88.24 to 98.88) (Fig. 10). The estimated between-study variance was τ^2=3.13. The profile likelihood plot for τ^2 demonstrated a distinct maximum likelihood peak at approximately 3.1 (Fig. 11).

Influence diagnostics, including casewise diagnostics (Supplemental Table 6, Available Online) and the Baujat plot (Fig. 12), identified Azevedo et al[35] (Virtuo Vivo) as a statistically influential study, exhibiting a standardized residual of −2.659 and the largest Cook distance in the dataset (0.534). Although this study was the only one formally classified as influential, Bader Eddin et al[8] also demonstrated a notable influence on the pooled RMS estimate, with a standardized residual of 2.249 and a considerable contribution to heterogeneity. The leave-one-out sensitivity

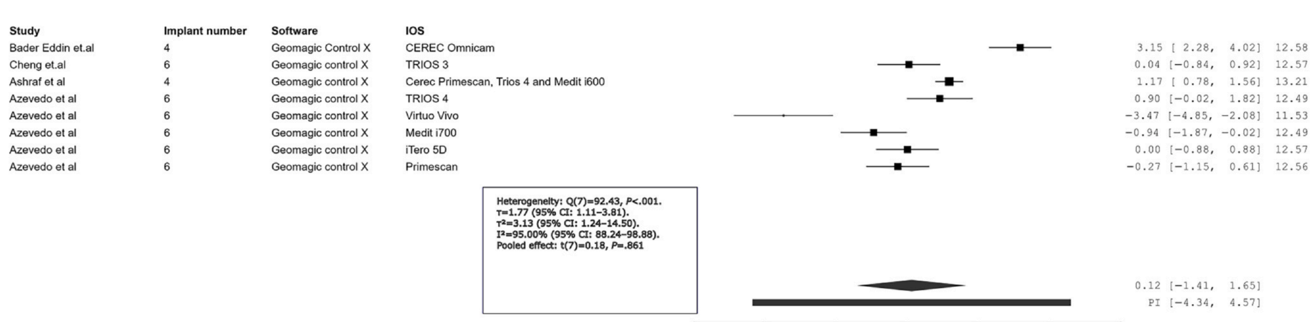

Figure 10. Forest plot of pooled RMS deviation estimates using random-effects meta-analysis (positive values (SMD>0) favor splinted technique [lower overall volumetric error]).

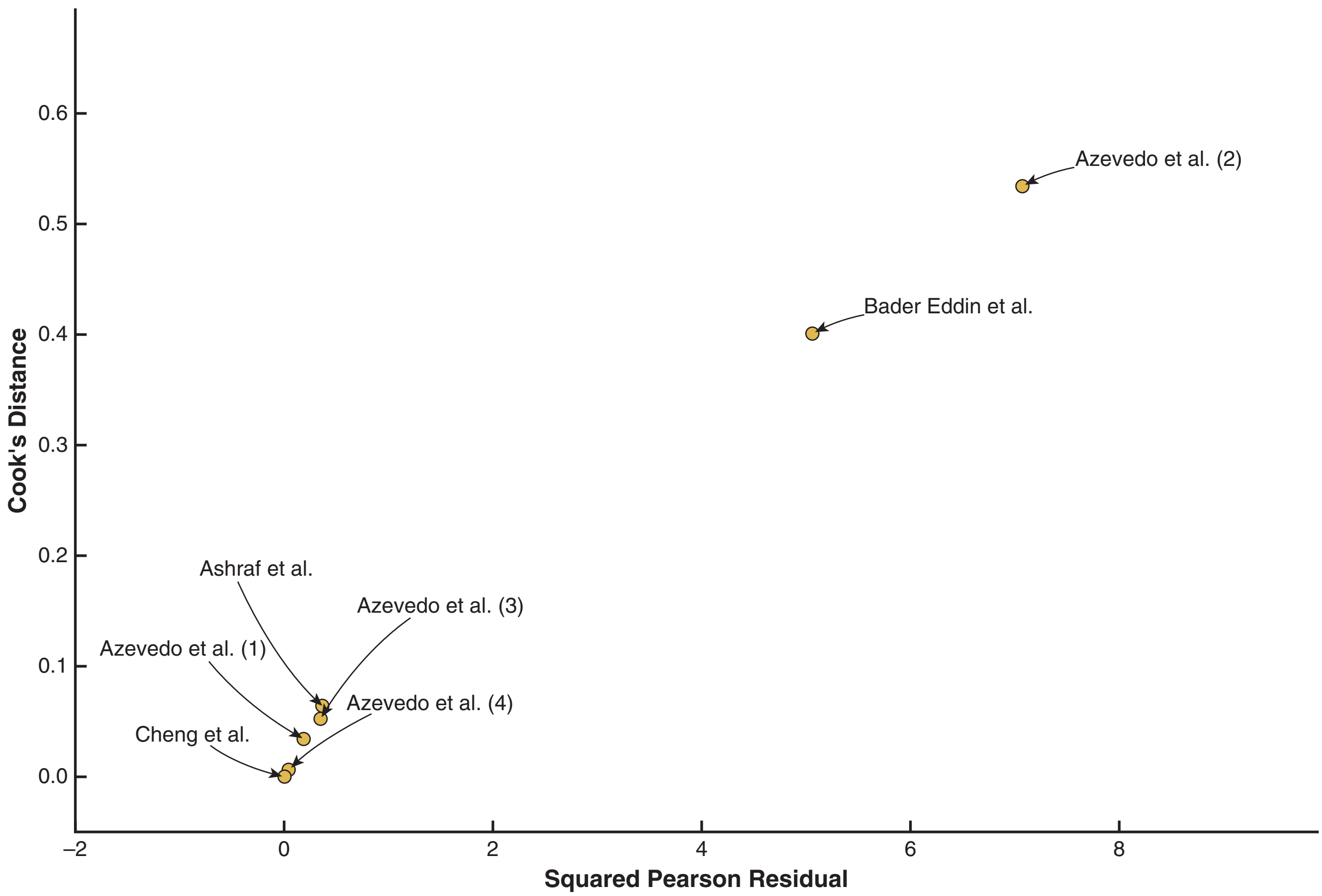

Figure 12. Baujat plot illustrating the contribution of individual studies to heterogeneity and influence on pooled RMS deviation estimate.

analysis indicated that exclusion of the Azevedo et al[35] study would substantially reduce heterogeneity, with τ^2 decreasing to 1.578 and the Qe declining to 57.05. The residual funnel plot further supported these findings (Fig. 13). The Egger test found no significant funnel plot asymmetry for any outcome (*P*>.05) (Table 2). Certainty of evidence was rated very low because of high heterogeneity, risk of bias, and imprecision. Overall, splinting improved linear accuracy, but the confidence in this effect was limited (Table 3).

DISCUSSION

The null hypothesis that no statistically significant differences would be observed between splinted and nonsplinted implant scan body configurations was partially rejected. Splinting significantly improved linear accuracy (*P*=.016); however, no statistically significant differences were detected for RMS or angular deviation, suggesting that the effect of splinting is outcome-specific rather than universal across all trueness parameters. However, results were based on few studies and were sensitive to influential treatment, so findings should be interpreted with caution. In addition, prediction intervals were wide (Figs. 2, 6, 10), indicating considerable uncertainty regarding the true magnitude and consistency of the effect across different clinical and experimental conditions.[39] Given the current lack of well-defined thresholds that clearly link linear deviation values to passive fit or long-term prosthetic performance, the clinical implications of statistically significant findings remain uncertain. In contrast, no statistically significant differences were observed for angular deviation or RMS deviation, suggesting that splinting did not consistently improve overall 3-dimensional trueness. Given the moderate to high heterogeneity observed across all outcomes, the presence of methodologic variability in trueness assessment, and the very low certainty of evidence ratings according to the GRADE framework (Table 3), the present meta-analysis findings should be regarded as exploratory and hypothesis-generating rather than confirmatory.[40]

The splinting methodology employed for the analyzed ISBs improved scanning outcomes by establishing a defined scanning pathway and reducing the risk of the scanner erroneously identifying one ISB as another, thereby minimizing inaccuracies and distortions in the

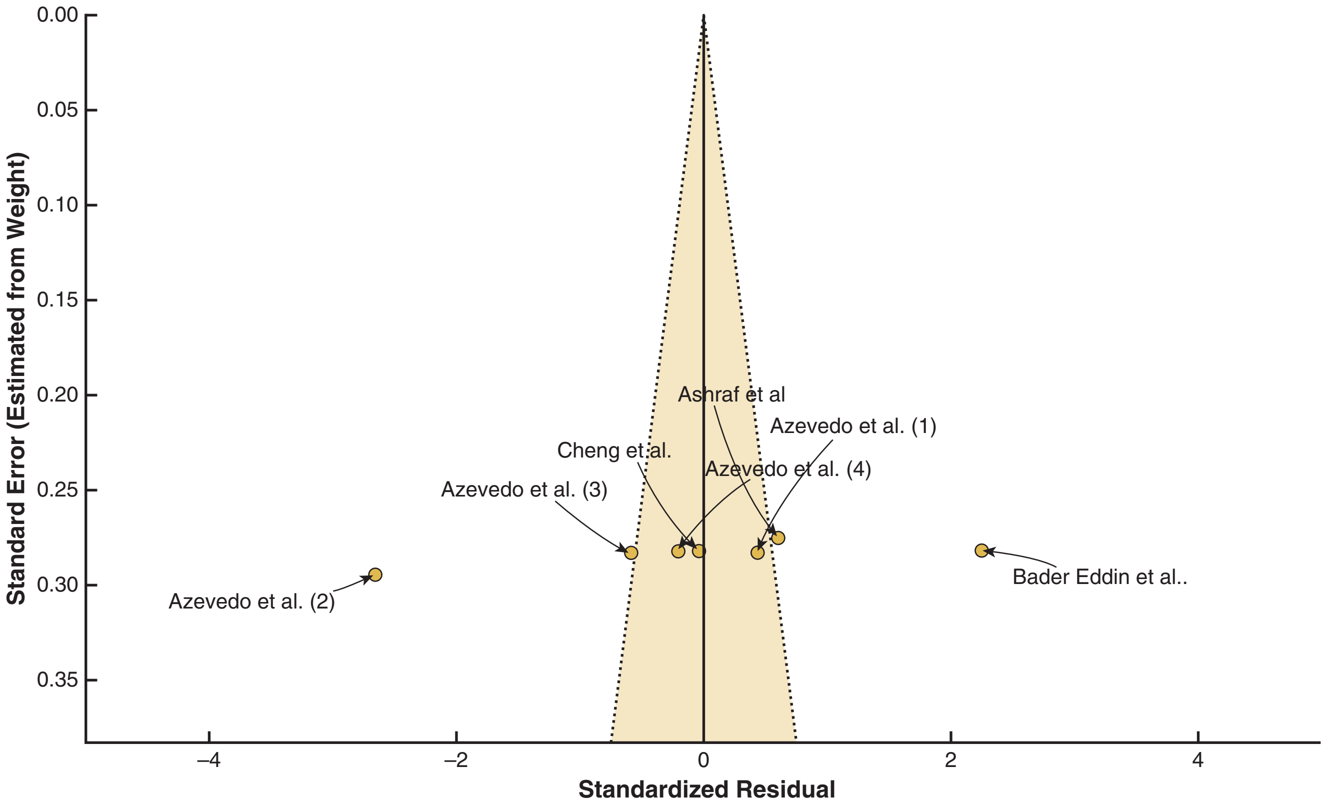

Figure 13. Residual funnel plot for RMS deviation meta-analysis, highlighting influential studies and substantial between-study heterogeneity.

definitive digital scan.[41] Mizumoto et al[41] reported that splinting ISBs resulted in greater distance deviation, suggesting no improvement in scanning precision, likely because of the use of dental floss as a splinting material affecting IOS performance.[36] In this meta-analysis, confounding factors such as splinting material, scan strategy, and IOS characteristics could not be isolated because of study heterogeneity.

Çakmak et al[42] reported that the choice of the evaluation software program significantly influenced reported deviation values. Measurements from metrology-grade software programs (GOM Inspect 2018; GOM GmbH and Geomagic Control X v.2018.1.1; 3D Systems) differed notably from those obtained with a non-metrology-grade software program (Medit Link v.2.4.4; Medit Corp), with GOM Inspect showing greater deviations than both Medit Link (P=.037) and Geomagic Control X (P=.029), while no significant difference was found between Medit Link and Geomagic Control X (P=.91).[42] In this meta-analysis, all studies used Geomagic Control X, minimizing variability from software program choice and improving outcome comparability. Meta-analysis diagnostics further identified the study by Azevedo et al[35] which employed the Virtuo Vivo IOS, as a statistically influential case for RMS deviation. This study exhibited a high standardized residual (−2.659) and the largest Cook distance among the included studies, indicating a disproportionate influence on the pooled effect estimate. This influence may be explained by the marked difference reported between the non-splinted (mean trueness=29) and splinted (mean trueness=49) configurations within that study. Notably, such discrepancies were not consistently observed with other IOS systems evaluated in the same investigation, suggesting that scanner-specific performance characteristics may contribute to the heterogeneity observed between splinted and non-splinted ISB configurations.[35]

Bader Eddin et al[8] was a highly influential outlier for both linear and angular deviation, and sensitivity analyses showed that excluding it substantially reduced

Table 2. Weighted regression (Egger) test for funnel plot asymmetry for linear deviation, angular deviation, and RMS deviation

Outcome Measure	No. of Outcomes	*t* Value	df	*P* Value	Limit Estimate (μ)	95% CI Lower	95% CI Upper
Linear deviation	14	−0.119	12	.907	0.619	−1.622	2.860
Angular deviation	7	0.292	5	.782	−0.422	−5.852	5.007
RMS deviation	8	−1.553	6	.171	2.318	−0.499	5.135

RMS, root mean square.

Table 3. GRADE summary of findings for the effect of splinted versus non-splinted ISBs on digital scan trueness

Outcome	No. of Studies (Comparisons)	Pooled Effect (SMD, 95% CI)	Prediction Interval	Certainty of Evidence (GRADE)	Explanation of GRADE Judgments
Linear deviation	6 studies (14 comparisons)	0.49 (0.11 to 0.88)	−0.75 to 1.74	⊕◯◯◯ Very Low	Risk of bias: Serious limitations due to moderate methodological concerns and influential outlier identified in sensitivity analyses. Inconsistency: Serious heterogeneity ($I^2 \approx 69\%$) indicating variability across studies. Imprecision: Serious, as confidence and prediction intervals were wide despite statistical significance. Indirectness: Not serious; outcomes and methods directly addressed the review question. Publication bias: Not detected (Egger's test P=.907).
Angular deviation	4 studies (7 comparisons)	0.22 (−0.94 to 1.38)	−2.89 to 3.33	⊕◯◯◯ Very Low	Risk of bias: Serious, due to methodological limitations and an influential outlier. Inconsistency: Very serious heterogeneity ($I^2 \approx 89\%$) with substantial between-study variability. Imprecision: Serious, as the confidence interval crossed the null and the prediction interval was very wide. Indirectness:Not serious. Publication bias: Not detected (Egger's test P=.782).
RMS deviation	4 studies (8 comparisons)	0.12 (−1.41 to 1.65)	−4.34 to 4.57	⊕◯◯◯ Very Low	Risk of bias: Serious, owing to moderate risk of bias and influential cases identified by casewise diagnostics. Inconsistency: Very serious heterogeneity ($I^2 \approx 95\%$), indicating extreme inconsistency. Imprecision: Serious, due to wide confidence and prediction intervals encompassing large benefit and harm. Indirectness: Not serious. Publication bias: Not detected (Egger's test P=.171).

GRADE, Grading of Recommendations Assessment, Development, and Evaluation; SMD, standardized mean difference

heterogeneity, likely due to differences in trueness assessment methods. In the study by Bader Eddin et al[8] ISB were converted into hollow virtual cylinders, and linear and angular distortions were calculated based on the Cartesian coordinates of centerlines passing through these cylinders. In contrast, other studies, such as that by Retana et al[37] employed point-based measurements on the ISB surfaces after superimposition with a reference STL file, calculating deviations based on distances between predefined reference points. These methodological discrepancies in trueness assessment likely contributed to variability in effect estimates. To mitigate the impact of such differences, standardized mean differences were applied in the present meta-analysis, allowing for a more robust comparison across studies using diverse measurement approaches. However, because SMD was used to account for variability in measurement scales and methodologies, the pooled effect size cannot be directly translated into a single absolute deviation value expressed in micrometers.

This systematic review and meta-analysis has several limitations. Included studies showed methodological heterogeneity in IOS systems, splinting materials, scanning strategies, implant configurations, and reference protocols, which may have affected pooled estimates. Most studies were in vitro, limiting clinical generalizability, and reporting was insufficient to assess the impact of splinting materials, ISB design, or scanner algorithms. Heterogeneity in metrics and analysis methods also reduces comparability, so findings cannot be directly applied to clinical accuracy or passive fit. Future research should use standardized protocols, uniform software, and well-defined splinting techniques to assess clinically meaningful improvements in complete arch implant-supported prostheses.

CONCLUSIONS

Based on the findings of this systematic review and meta-analysis, the following conclusions were drawn:

1. Splinting implant ISBs may be associated with differences in trueness when evaluated in terms of linear deviation; however, this finding should be interpreted cautiously given the limited evidence base and heterogeneity among studies.
2. No statistically significant differences were observed between splinted and non-splinted ISB techniques for angular deviation or RMS deviation, indicating that splinting does not consistently enhance overall 3-dimensional accuracy.
3. Scanner-specific performance characteristics and methodological differences contributed to heterogeneity among studies, suggesting that the effectiveness of splinting may depend on the IOS system and assessment protocol used.

APPENDIX A. SUPPORTING INFORMATION

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.prosdent.2026.04.028.

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