

SYSTEMATIC REVIEW

Clinical outcomes of immediate versus early or conventional loading of single implants: A de novo RCT-level meta-analysis with contextual synthesis of systematic reviews



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ABSTRACT

Statement of problem. Immediate loading of single implants has been widely used to reduce treatment time and improve patient convenience. However, uncertainty remains regarding its long-term survival, marginal bone stability, and prosthetic reliability compared with early or conventional loading protocols.

Purpose. The purpose of this study was to synthesize the available randomized controlled trial (RCT) evidence comparing immediate loading with early or conventional loading of single implants, using trial-level meta-analysis with contextual evaluation of existing systematic reviews.

Material and methods. Electronic searches of the PubMed, Embase, Scopus, Epistemonikos, and Cochrane databases were conducted through October 2025. Systematic reviews restricted to RCTs were identified, and all eligible primary RCTs were re-extracted to avoid double counting. Overlap among reviews was quantified with the Corrected Covered Area. Random-effects meta-analyses were performed to calculate risk ratios (RR) for implant survival and complications, mean differences (MD) for marginal bone loss (MBL), and standardized mean differences (SMD) for patient-reported outcomes. Follow-up intervals were analyzed separately (1, 2, 3, and 5 years). The certainty of evidence was assessed with GRADE.

Results. Seven systematic reviews and 2 additional RCTs were identified, yielding 40 unique trials and more than 1200 single implants with follow-up ranging from 1 to 10 years. Evidence overlap among reviews was high (CCA=11.5%). No statistically significant differences were found in implant survival between immediate and conventional loading at 1 year (RR=1.00; 95% CI, 0.98 to 1.02), 2 years (RR=1.01; 95% CI, 0.96 to 1.05), 3 years (RR=1.01; 95% CI, 0.97 to 1.05), or 5 years (RR=1.00; 95% CI, 0.97 to 1.03), nor between immediate and early loading at 1 year (RR=0.99; 95% CI, 0.96 to 1.02). Differences in MBL were minimal and clinically negligible at all time points. Patient satisfaction did not differ significantly between protocols, and prosthetic and biologic complications were infrequent in both groups. The certainty of evidence was moderate for survival and low to very low for secondary outcomes.

Conclusions. When applied under appropriate clinical conditions, immediate loading of single implants demonstrated survival, marginal bone stability, complication rates, and patient satisfaction comparable to early or conventional loading. (J Prosthet Dent 2026;136:702-715)

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Clinical Implications

Immediate loading appears to provide comparable survival and complication rates to conventional protocols. Prosthodontists may consider immediate loading to reduce treatment time without compromising medium-term clinical outcomes when biomechanical and occlusal conditions are favorable.

Implant-supported prostheses have transformed contemporary prosthodontics by enabling predictable, long-term rehabilitation for partial or complete edentulism.¹ Advances in implant macro- and micro-geometry, surface topography, surgical techniques, and digital planning have further expanded indications, including single-tooth replacement in both esthetic and posterior regions.^{1,2} Traditionally, conventional (delayed) loading protocols, allowing several months of unloaded healing, were regarded as the standard.³ More recently, patient-centered demands for shorter treatment times and immediate esthetics have driven a shift toward immediate and early loading.⁴⁻⁶

Terminology for implant loading protocols has been standardized through international consensus statements.⁷ Primary stability remains the key prerequisite for immediate or early loading⁷⁻¹⁰ and has been reported to be influenced by implant design, surface characteristics, osteotomy preparation, and bone quality.^{11,12} Clinical decision-making has been further shaped by patient-, implant-, and site-related factors, as systemic conditions, bone density, and anatomical location may support or contraindicate accelerated loading.¹³⁻²¹ Immediate loading offers advantages such as reduced treatment time, immediate esthetics and patient satisfaction,²² but these must be balanced against potential risks including early failure, soft-tissue complications, and prosthetic challenges.²³⁻²⁵

A substantial body of literature has compared immediate with early or conventional loading for single-tooth implants, generally reporting similar survival rates, marginal bone stability, and complication profiles.²⁶⁻³⁷ However, overlap among reviews may result in double counting of primary trials.³⁸ Existing syntheses vary in inclusion criteria, follow-up, and outcomes, particularly for complications and patient-reported outcomes, limiting clinical applicability. Inconsistent time stratification and limited evaluation of key modifiers (implant placement timing, anatomical region, jaw) further restrict interpretation. Methodological quality and handling of overlapping data also differ across reviews, and most lack time-stratified certainty assessments and robustness analyses. Since the latest comprehensive review,³⁹ additional RCTs, including long-term data, have emerged,

warranting an updated synthesis. Overviews of systematic reviews provide a structured approach to evaluate high-level evidence,⁴⁰ provided that overlap, quality, and certainty are assessed.³⁸

This systematic review and meta-analysis evaluated RCTs comparing immediate versus early or conventional loading of single implants, with analyses stratified by follow-up. The primary outcome was implant survival, while marginal bone loss (MBL), prosthetic and biological complications, and patient-reported outcomes (PROs) were secondary endpoints. The null hypothesis was that no significant differences would exist between loading protocols for implant survival or secondary outcomes.

MATERIAL AND METHODS

The present study was conducted according to the PRISMA 2020 statement and followed the Preferred Reporting Items for Overviews of Reviews (PRIOR) framework.⁴⁰ In line with Preferred Reporting Items for Overviews of systematic reviews (PRIO-harms) guidance, complications and adverse outcomes related to implant-supported prostheses were systematically extracted and reported alongside benefits.⁴¹ The protocol had been registered in PROSPERO (CRD420251009161). The final database search was performed in October 2025.

Systematic reviews of RCTs were screened to map the evidence base; however, all eligible primary RCTs were re-extracted and synthesized *de novo* to avoid double counting and harmonize the follow-up. Overlap was quantified by using the corrected covered area (CCA). Included were meta-analyses of RCTs comparing immediate with and/or conventional loading of single-tooth titanium implants in adults (≥ 18 years). The primary outcome was implant survival at predefined follow-ups; secondary outcomes included MBL, PROs, and prosthetic and biological complications. Reviews of fixed complete dentures or overdentures, non-systematic reviews, abstracts, and studies including non-randomized designs were excluded. Only English-language articles were considered. Searches were conducted in the PubMed, Embase, Epistemonikos, Scopus, and Cochrane (CDSR/CENTRAL) databases, supplemented by reference and nonpeer-reviewed literature screening and hand-searching of major implant conference proceedings (past 5 years). Searches were updated to October 2025, using controlled vocabulary and free-text terms, with strategies adapted per database (see [Supplemental Material 1](#), available online). Records were de-duplicated and screened, and a top-up search identified additional RCTs. Two reviewers (A.P., E.P.) independently screened titles and abstracts and full texts against eligibility criteria. Disagreements were resolved by discussion or by a third

reviewer (A.B.H.), and reasons for full-text exclusions were recorded. The selection process followed PRISMA 2020. RCTs identified through the top-up search were screened using the same criteria and included in the de novo meta-analyses when eligible.

Review-level data (authors, year, number of RCTs, comparisons, sample size, implant site, search strategy, follow-up, outcomes, and conclusions) were extracted from the included systematic reviews. All primary RCTs were retrieved and re-extracted from original reports. Multiple publications were consolidated to ensure each cohort contributed once per follow-up (1, 2, 3, and 5 years). Extracted outcomes included implant survival, MBL, complications, and PROMs. Missing data were derived when sufficient information was available (such as calculation from reported statistics or estimation from available data). When required, corresponding authors were contacted to obtain additional information. PROMs were harmonized using standardized mean differences when appropriate. Immediate loading was classified as functional or non-functional based on occlusal contact. Data extraction was performed by one reviewer (A.P.) and verified by a second (E.P.), with discrepancies resolved by consensus. Supplementary sources were consulted when needed. Redundancy among systematic reviews was assessed using a citation matrix (RCTs $\times$ reviews) and quantified with the corrected covered area (CCA).⁴² Values were interpreted as slight (0 to 5%), moderate (6 to 10%), high (11 to 15%), or very high (>15%). Overlap analysis was descriptive, while quantitative syntheses used de-duplicated trial data. Methodological quality was assessed with AMSTAR 2,⁴³ with independent evaluation by 2 reviewers and consensus resolution. Overall confidence was rated as high, moderate, low, or critically low. Risk of bias for RCTs from the top-up search was assessed using RoB 2.⁴⁴ Certainty of evidence was evaluated using GRADE, by outcome and follow-up.⁴⁵

Random-effects models were used to account for between-study variability. Binary outcomes were expressed as risk ratios (RRs) and continuous outcomes as mean differences (MD) or standardized mean differences (SMD), with Hedges g used for PROMs. Between-study variance (τ^2) was estimated using restricted maximum likelihood (REML) (see [Supplemental Material 2](#), available online). To address multiple follow-ups, analyses were stratified at 1, 2, 3, and 5 years, with each trial contributing 1 estimate per stratum. Subgroup analyses were performed by implant placement timing, jaw, region, and occlusal loading (functional versus non-functional). A specific subgroup analysis was conducted for 1-year implant survival (immediate versus conventional loading). Sensitivity analyses excluded trials with zero events (survival) and applied leave-one-out methods for MBL when heterogeneity was substantial ($I^2 > 50\%$).

Publication bias was assessed using funnel plots and the Egger test when ≥ 10 RCTs were available. Analyses were carried out in a statistical software program (R Version 2025.09.2+418; RStudio) ($\alpha = .05$). Detailed statistical procedures, software implementation, and additional methodological specifications are provided in [Supplemental Material 1](#), available online.

RESULTS

The search yielded 3926 records; after removing 1336 duplicates, 2590 were screened. A total of 25 full texts were assessed, and 7 systematic reviews met the inclusion criteria. A top-up search identified 2 additional RCTs.^{46,47} No single prior review included all eligible RCTs because of differences in scope and criteria, and no further studies were identified through hand searching. The selection process is shown in [Figure 1](#). Inter-reviewer agreement during title/abstract screening was high (99.8%; 95% CI, 99.6 to 100.0%), with 5 discrepancies resolved by consensus. Agreement was complete at full-text screening (100%), and data extraction showed high agreement (>98%), with all discrepancies resolved. The 7 included systematic reviews (2014–2025) analyzed RCTs with follow-up periods of 1 to 10 years, comparing immediate with early and/or conventional loading of single titanium implants in systemically healthy adults. Implant sites included anterior and posterior regions of both jaws ([Table 1](#)). Survival and MBL were the most commonly reported outcomes, while PROMs and complications were less consistently described. Two additional RCTs compared immediate and conventional loading, with follow-ups of 10 years⁴⁷ and 1 year.⁴⁶

A citation matrix mapped RCT overlap across the 7 reviews. The CCA heatmap ([Fig. 2](#)) showed pairwise overlap from 0% to 50%, with some reviews including distinct RCTs, while others showed substantial overlap, particularly Benic et al⁴⁸ with Cheng et al⁴⁹ (50%) and Qin et al⁵⁰ with Pitman et al²⁶ (44.4%). Qian et al⁴⁰ demonstrated modest overlap with Benic et al (17.9 to 25%). Overall, redundancy was high (CCA=11.5%), with repeated inclusion of several RCTs ([Figs. 2, 3](#)), supporting de novo synthesis. AMSTAR-2 assessment ([Fig. 4](#)) rated 2 reviews^{23,38} as moderate confidence and the remainder as low. Common limitations included lack of protocol registration, incomplete reporting of exclusions, and inadequate consideration of bias. Additional RCTs showed low risk or some concerns, mainly in allocation concealment and blinding ([Fig. 5](#)). GRADE certainty was moderate for survival, low to moderate for MBL, and low for PROMs ([Table 2](#)), with limitations driven by imprecision, heterogeneity, and outcome

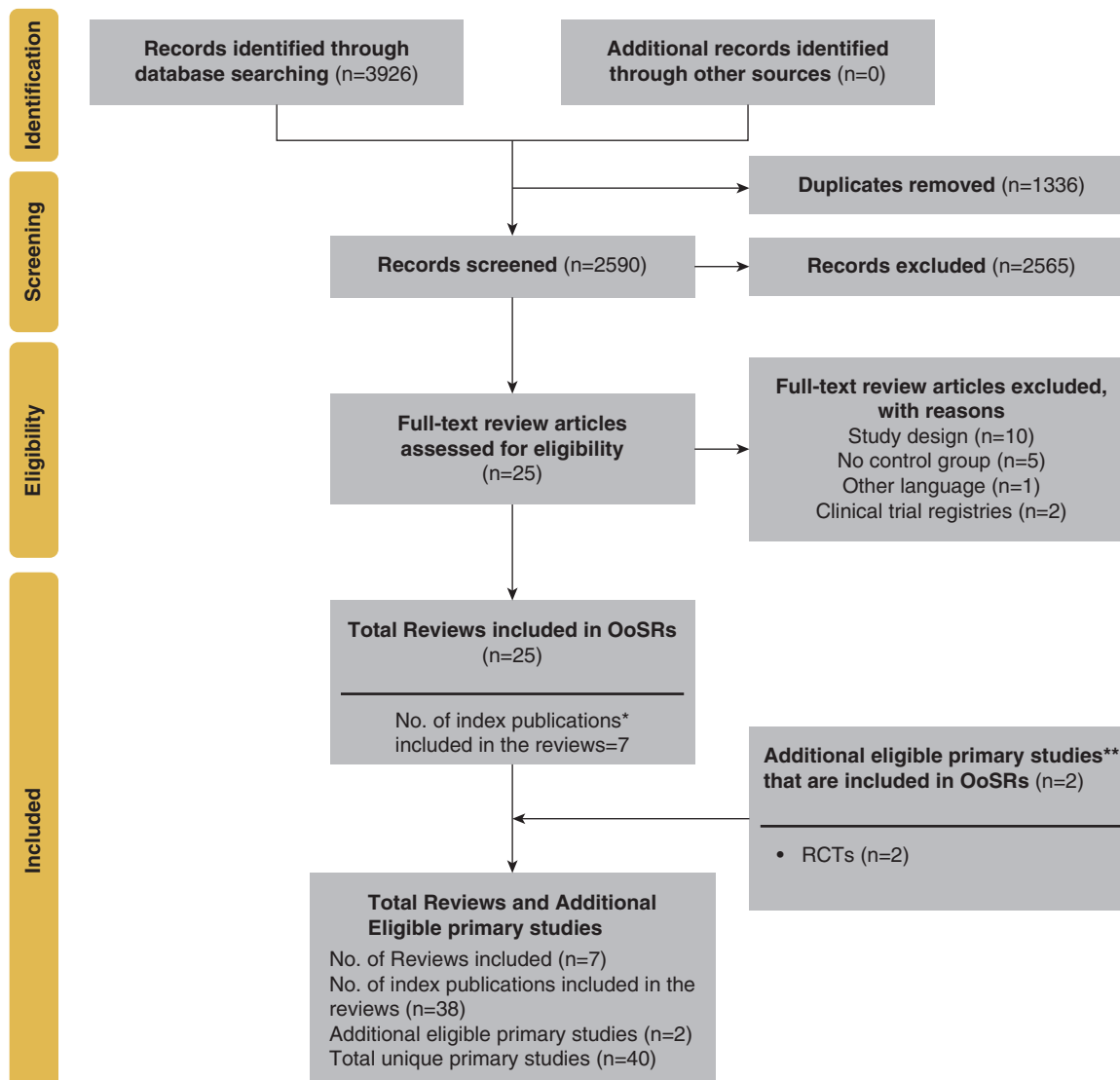


Figure 1. Flow diagram of identification and selection of included reviews.

variability. Overall, evidence supports comparable short- to mid-term outcomes across loading protocols.

Meta-analyses demonstrated no significant differences in implant survival between immediate and non-immediate loading across all follow-up intervals (1 to 5 years) (Figs. 6–10). Survival rates were consistently similar, with negligible heterogeneity. Prediction intervals encompassed the null effect, suggesting that clinically meaningful differences were unlikely under similar conditions. Detailed effect estimates are provided in Supplemental Table 1 (available online). No significant differences in MBL were observed between immediate and non-immediate loading at any follow-up interval (1, 3, and 5 years) (Figs. 11–13). Differences were small and below thresholds of clinical relevance. Moderate to high heterogeneity was observed at longer follow-up periods. Detailed results are presented in Supplemental Table 2,

available online. PROMs showed no significant differences between loading protocols at 1 and 5 years (Figs. 14, 15). However, substantial heterogeneity and variability in measurement instruments limited the precision of estimates. Detailed effect sizes are provided in Supplemental Table 3, available online. Prosthetic complications were infrequent and did not differ between immediate and non-immediate loading protocols at short- and mid-term follow-up (Figs. 16, 17). Detailed results are presented in Supplemental Table 4, available online. Biological complications were rare across all studies, and no meaningful differences between loading protocols could be identified. Meta-analysis was not feasible because of very low event rates.

Sensitivity and subgroup analyses for 1-year outcomes are summarized in Supplemental Table 5 and Supplemental Figures 1–6, available online. The results

Table 1. Main characteristics of included studies

Authors	Year	number of RCTs	Comparison	number of implants	number of patients	Region	Jaw	Available protocol	Databases	Search time limit	Mean follow-up	Key findings
Qian X et al.	2025	43	Immediate versus early/ conventional	2147	NR	Anterior	Maxilla	Yes	7	until January 2024	1–5 years	Immediate implantation with immediate loading showed considerable esthetic advantage over later rehabilitation
Qin R et al.	2023	8	Immediate versus conventional	324	349	Anterior	Maxilla	Yes	4	until December 2021	1–5 years	Immediate implant Placement With or Without Immediate
Pitman J et al.	2022	7	Immediate versus early/ conventional	323	323	Both	Both	Yes	4	until September 2021	1–5 years	Provisionalization Implant survival not significantly affected by immediate
Cheng Q et al.	2020	7	Immediate versus conventional	386	NR	Anterior	Maxilla	No	3	until April 2018	1 year	Short-term follow-up of single-tooth implants in the esthetic zone showed the loading protocols (conventional or immediate loading) not likely to influence the clinical outcomes, including implant survival
Pigozzo MN et al.	2018	5	Immediate versus early	287	NR	Both	Both	Yes	3	until May 2016	3 years	No significant differences in survival rate between early and immediate loading protocols in single implant crowns
Moraschini and Barboza	2016	5	Immediate versus conventional	286	177	Posterior	Mandible	No	3	until January 2015	31.2 months	No significant differences between immediate and conventional loading of posterior single implants in the mandible.
Benic G et al.	2014	11	Immediate versus early/ conventional	597	NR	Both	Both	No	2	until August 2012	1–5 years	Immediately and conventionally loaded single-implant crowns equally successful regarding implant survival

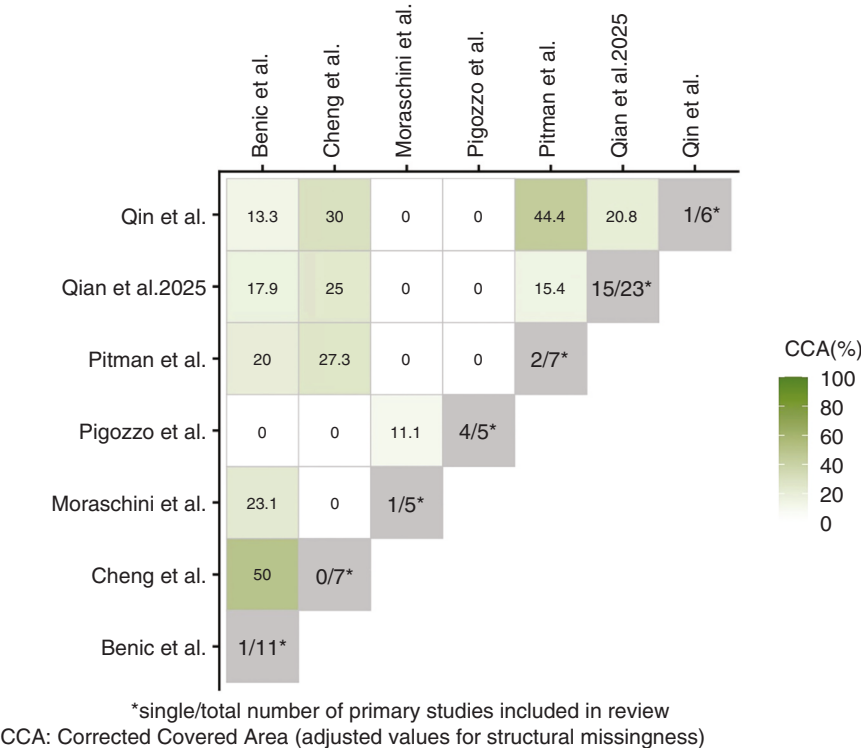


Figure 2. Corrected covered area (CCA) heatmap summarizing pairwise overlap of primary studies across seven included reviews. Higher CCA values indicate greater overlap, shown by progressively darker shading. Diagonal annotations represent proportion of single-included studies within each review. CCA adjusted for structural missingness.

remained stable across all analyses, with no evidence that implant placement timing, anatomical region, jaw location, or occlusal scheme influenced survival outcomes.

For implant survival at 1 year, visual inspection of the funnel plot (Fig. 18) and Egger regression test could not demonstrate significant asymmetry ($P=.069$), suggesting no clear evidence of publication bias. However, given the limited number of contributing trials, these findings should be interpreted cautiously. For other outcomes, formal assessment of publication bias was not feasible because of the small number of included studies.

DISCUSSION

The results of this study did not support rejecting the null hypothesis that no significant differences would exist between loading protocols for implant survival or secondary outcomes, indicating that immediate loading of single implants does not significantly differ from early or conventional with respect to implant survival and other evaluated clinical outcomes. This de novo RCT-level meta-analysis, complemented by a contextual synthesis of systematic reviews, integrated the highest level of available evidence. Although 7 systematic reviews were identified, none incorporated the full body of

eligible RCTs because of differences in scope and eligibility criteria. The observed overlap (CCA=11.5%) further highlighted redundancy across reviews and supported the need for trial-level re-analysis. From a prosthodontic perspective, these findings supported flexibility in loading protocols when biomechanical and patient-specific criteria are appropriately satisfied.

Across all follow-up intervals, immediate loading showed survival rates statistically and clinically similar to early or conventional loading. Effect estimates clustered around the null, with prediction intervals indicating clinically relevant differences as unlikely. These findings aligned with high-level evidence and consensus reports supporting comparable survival outcomes when appropriate patient selection and technical criteria are met.^{30–34} The 2023 and 2018 ITI Consensus Reports similarly suggested immediate loading of single implants as safe and predictable under controlled conditions.^{7,32,35} Similar results have also been reported in RCTs.^{36,37,47} Although some studies indicated slightly higher early failure rates in specific contexts,^{51,52} these appear to be related to clinical factors such as implant location or prosthetic design rather than loading timing itself.^{20,21} Overall, survival rates remain high across protocols, emphasizing the importance of patient selection and adherence to surgical and prosthetic principles.^{20,23}

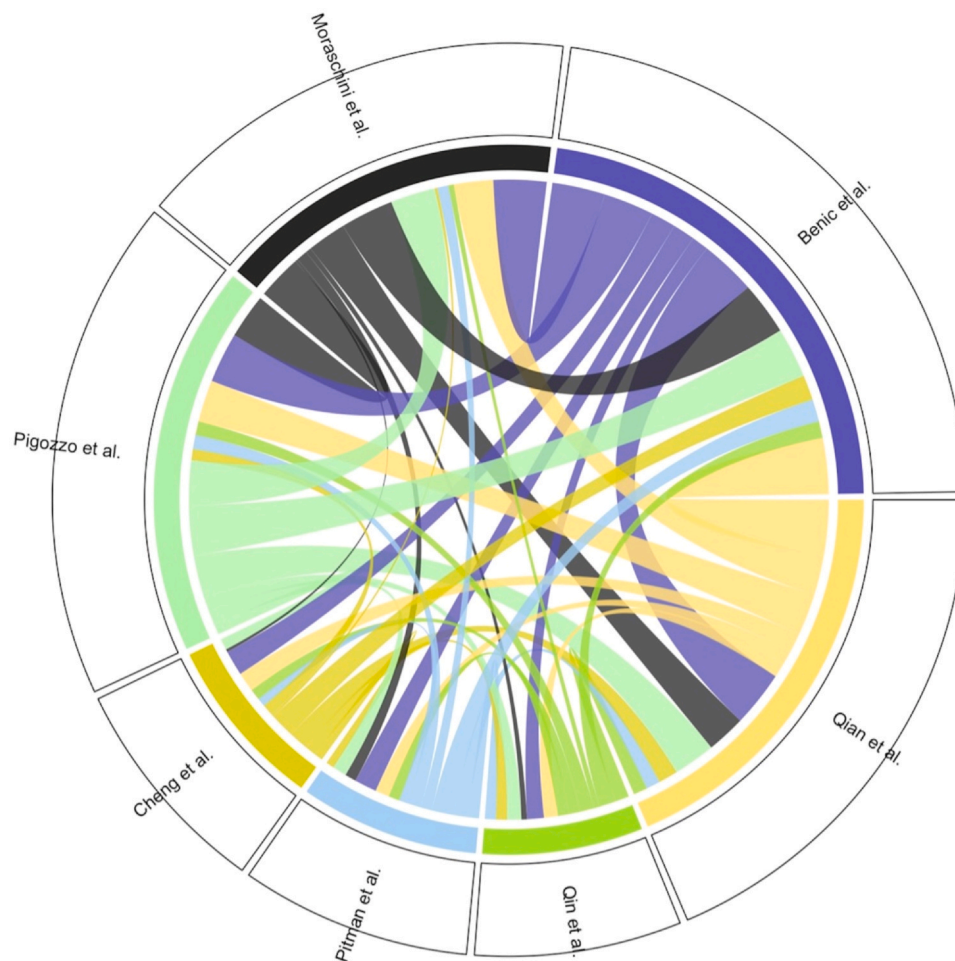


Figure 3. Chord diagram of overlap across reviews.

Marginal bone stability is a key indicator of long-term implant success. Differences in MBL between immediate and non-immediate loading at 1, 3, and 5 years were minimal and below clinical relevance thresholds.³⁰ This finding aligned with evidence showing no clinically relevant differences for immediate loading when appropriate stability and patient selection are ensured,^{30,35,47,51} although some studies report slightly lower bone loss.²⁰ Heterogeneity at longer follow-ups likely reflected methodological factors, including radiographic methods, reference points, and follow-up timing, as well as clinical variability related to implant design, primary stability, prosthetic protocols, and patient characteristics, rather than true biological differences. Despite this, effect estimates consistently clustered around zero, suggesting variability influenced dispersion rather than the magnitude or direction of effect.²⁸

This de novo RCT-level meta-analysis provides insight into under-reported PROs in implant research. Despite assumptions that immediate loading improves satisfaction, no significant differences were found at 1 or

5 years. High satisfaction has been reported for both protocols,^{20,22,37} with no clear patient preference for immediate loading.³¹ Heterogeneity in PROMs, timing, and small sample sizes likely limited sensitivity, reflecting both methodological and clinical variability in expectations, esthetic demands, and treatment priorities. Use of non-standardized or non-validated PROMs further reduced comparability. Immediate loading may offer short-term convenience but does not translate into superior long-term PROMs, highlighting the need for validated measures, appropriate counseling, and shared decision-making.²²

Prosthetic complications were infrequent and comparable across loading protocols, with minor events such as veneer chipping, interim crown fracture, or occasional screw loosening resolving without affecting implant survival. This finding was consistent with reports of low technical complication rates (approximately 3% annually)³² and no significant differences between immediate and conventional protocols.²⁰ Biological complications were likewise rare, with isolated cases of peri-implant mucositis or peri-implantitis precluding

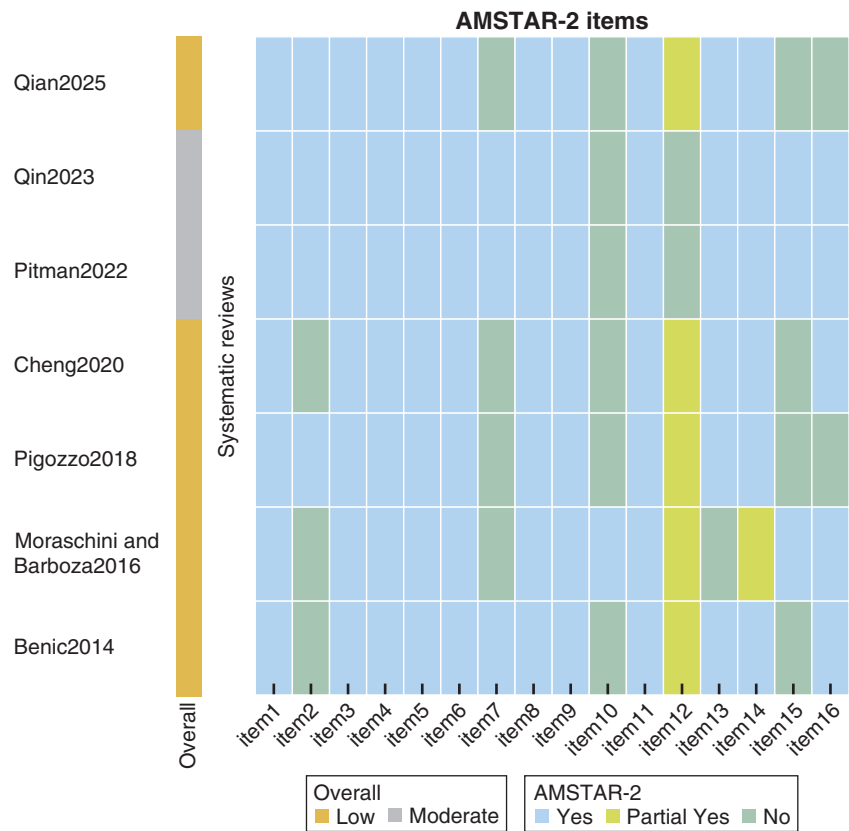


Figure 4. Heatmap of AMSTAR-2 item-level assessments for included systematic reviews. Color coding represents Yes, Partial Yes, and No responses; left annotation denotes overall review confidence.

meaningful meta-analysis, consistent with previous findings.^{20,32} Overall, complication risk appears more related to surgical and prosthetic execution and maintenance than to loading timing.

A key methodological challenge was the high overlap among existing systematic reviews. The observed CCA (11.5%) indicates substantial redundancy, potentially inflating certainty because of repeated inclusion of the

same RCTs. De novo trial-level meta-analyses mitigate this by avoiding double counting and incorporating newer studies. AMSTAR-2 assessments identified weaknesses in critical domains, indicating the need for more rigorous and transparent syntheses.

This overview combined an umbrella review with an RCT-level meta-analysis, providing a harmonized synthesis of RCTs rather than relying on prior aggregated

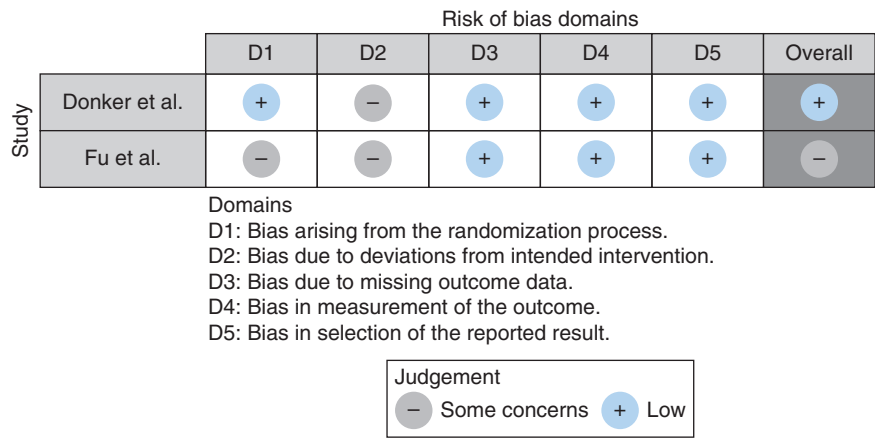
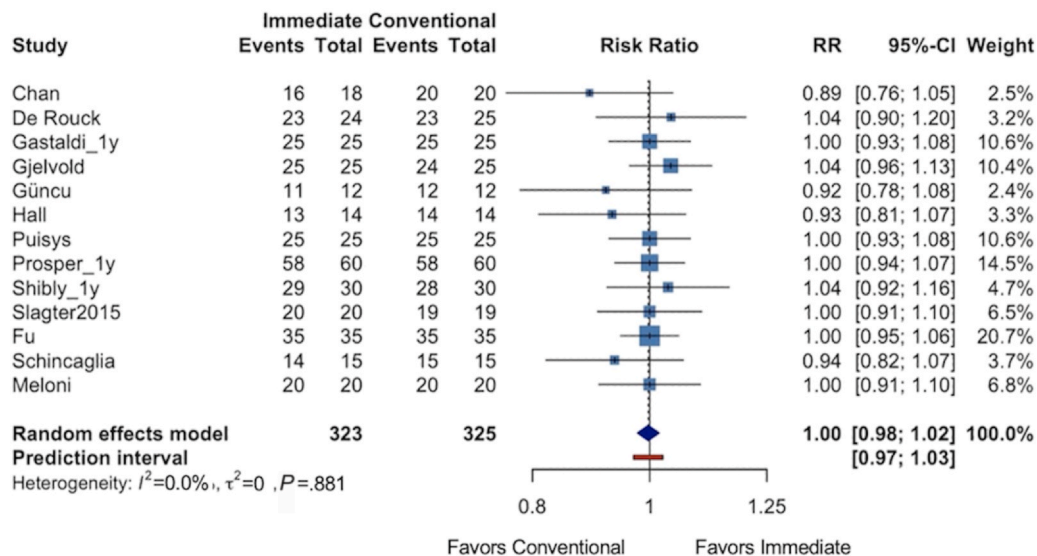


Figure 5. Risk of bias assessment for included RCTs, applying RoB 2.0 tool. Figure summarizes judgments across 5 domains of bias for each study and provides overall risk-of-bias assessment.

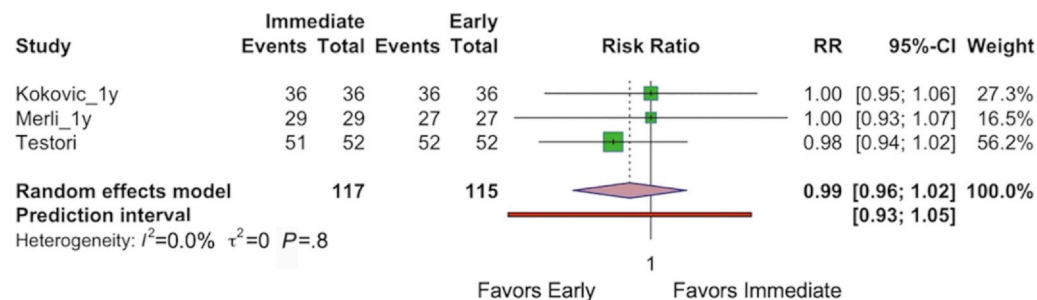
Table 2. GRADE summary of findings table

Outcome	No. of studies (design)	Certainty of evidence (GRADE)	Relative effect	Comments / Notes
Implant Survival	16 RCTs	●●● Moderate	1-year: immediate versus delayed RR=1.00 (0.98–1.02), immediate versus early RR=0.99 (0.96–1.02), 3-year RR=1.01 (0.97–1.06), 5-year: RR=1.00 (0.97–1.03)	Similar survival for immediate and conventional loading; low heterogeneity ($I^2=0\%$)
Marginal bone loss	12 RCTs	●● Low	1-year: MD=−0.01 mm (−0.1 to 0.08), 3-year: MD=0.06mm (−0.50–0.62), 5-year: MD=−0.07mm (−0.42–0.28)	Heterogeneity ($I^2=56\%$) and small sample; no significant difference.
Biological/prosthetic complications	6 RCTs	●● Low	1-year: RR=0.76 (0.38–1.52), mid-term RR=1.09 (0.39–3.03)	Data sparse and inconsistently reported.
PROMs	3 RCTs	●●●● Very Low	1-year: SMD=−0.20, 95% CI: −1.90 to 1.50, 5-year: SMD=0.03 (−3.43–3.48)	High heterogeneity ($I^2=79\%$), different instruments and timepoints, small sample size and very wide CI crossing no effect → imprecision and inconsistency lead to downgrading.

**Figure 6.** Forest plot comparing 1-year implant survival between immediate and conventional loading. Risk ratios (RR) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

data. Overlap analysis (CCA) revealed substantial redundancy among existing reviews, supporting the need for de novo synthesis. Inclusion of recent RCTs and time-stratified analyses enhanced clinical relevance across follow-up periods. Methodologically, the study applied established tools (CCA, AMSTAR-2, RoB 2.0, GRADE)

and adhered to PRIOR and PRIO-harms, with sensitivity analyses, prediction intervals, and clinically relevant subgroup analyses supporting robustness. However, most data derived from systemically healthy patients, limiting generalizability. Heterogeneity in outcome definitions, particularly for PROMs and MBL, and low event rates for

**Figure 7.** Forest plot comparing 1-year implant survival between immediate and early loading. Risk ratios (RR) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

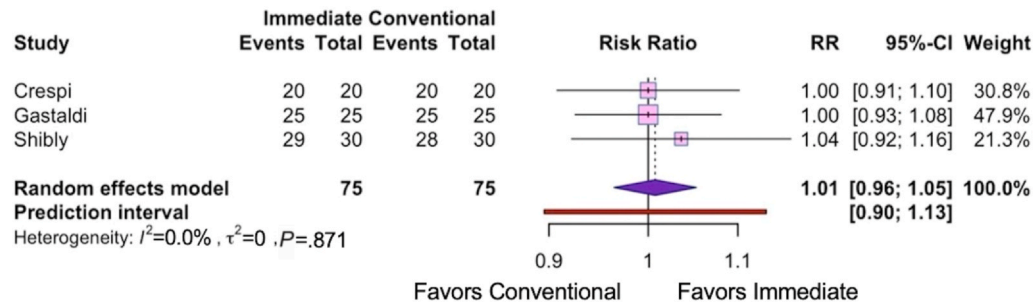


Figure 8. Forest plot comparing 2-year implant survival between immediate and conventional loading. Risk ratios (RR) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

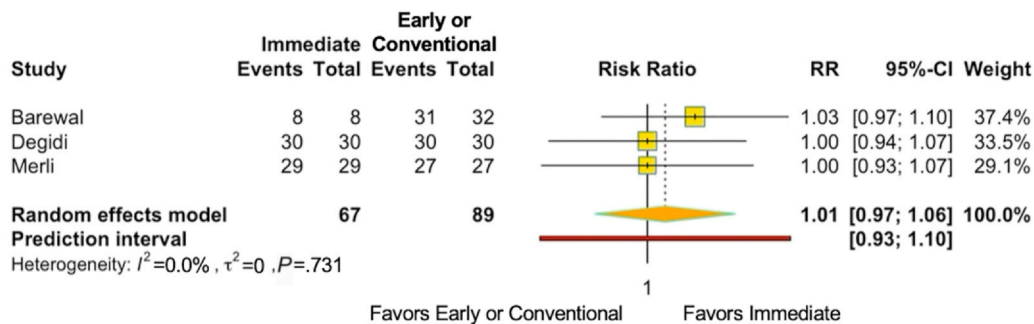


Figure 9. Forest plot comparing 3-year implant survival between immediate and early or conventional loading. Risk ratios (RR) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

complications reduced comparability and precision. Subgroup findings should be interpreted cautiously because of limited data, and restriction to English-language studies may introduce bias. Finally, long-term RCTs beyond 10 years remain scarce.

Current evidence supports immediate loading as a predictable option for single implants in carefully selected, systemically healthy patients. However, caution is warranted in patients with systemic risk factors (like smoking, diabetes), esthetically demanding regions, or suboptimal primary stability or bone quality, where

delayed loading may be preferable. Immediate loading should be considered only when optimal implant positioning and adequate primary stability are achieved. Treatment decisions should be individualized based on stability, anatomical and biomechanical factors, and patient risk profile, with appropriate counseling and shared decision-making given uncertainties in long-term patient-reported outcomes. Future research should prioritize standardized outcome sets, including validated PROMs and clinician-reported outcomes, and involve more diverse populations. Consistent reporting of

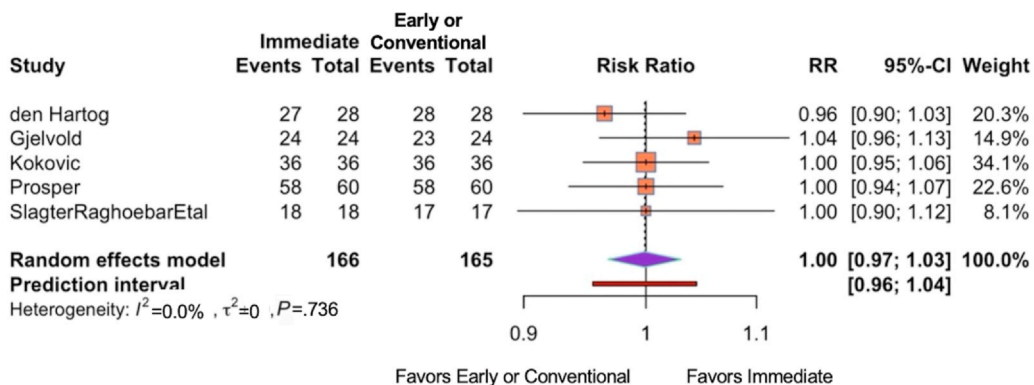


Figure 10. Forest plot comparing 5-year implant survival between immediate and early or conventional loading. Risk ratios (RR) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

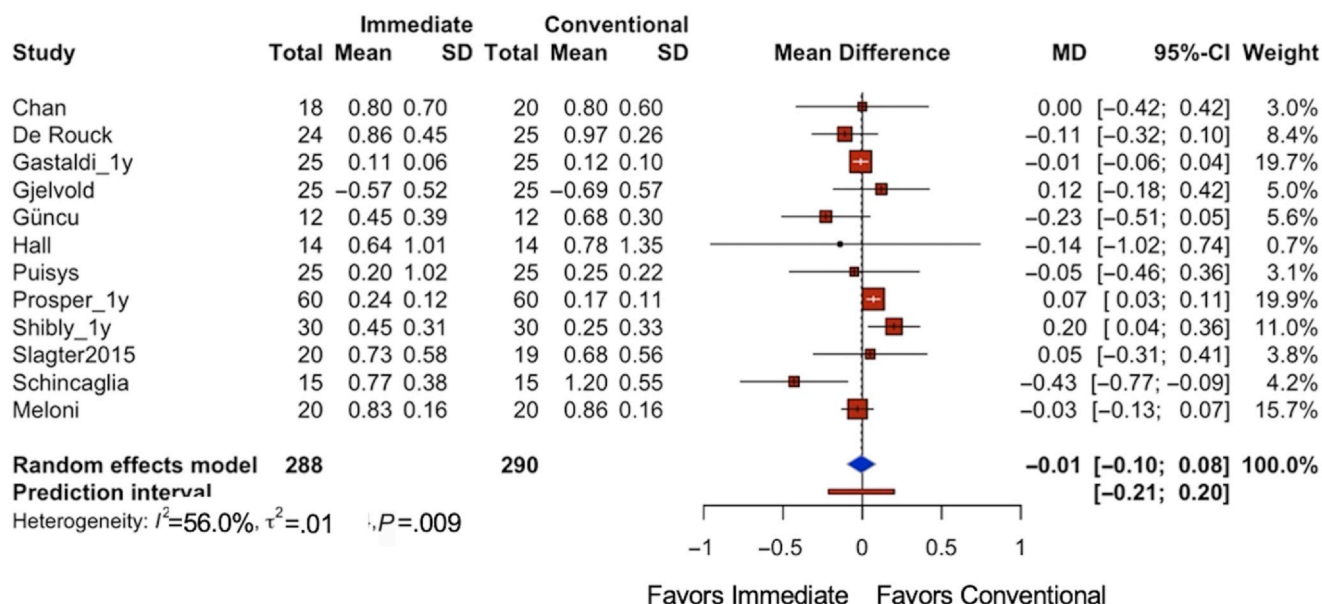


Figure 11. Forest plot comparing 1-year MBL between immediate and conventional loading. Mean Difference (MD) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

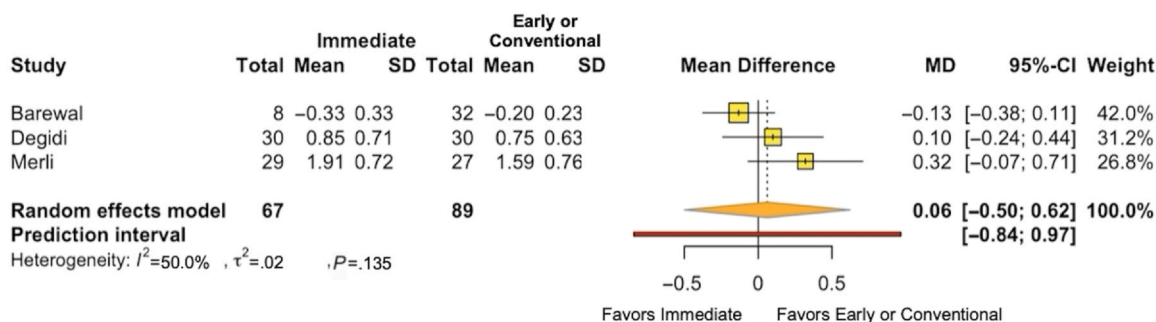


Figure 12. Forest plot comparing 3-year MBL between immediate and early or conventional loading. Mean Difference (MD) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

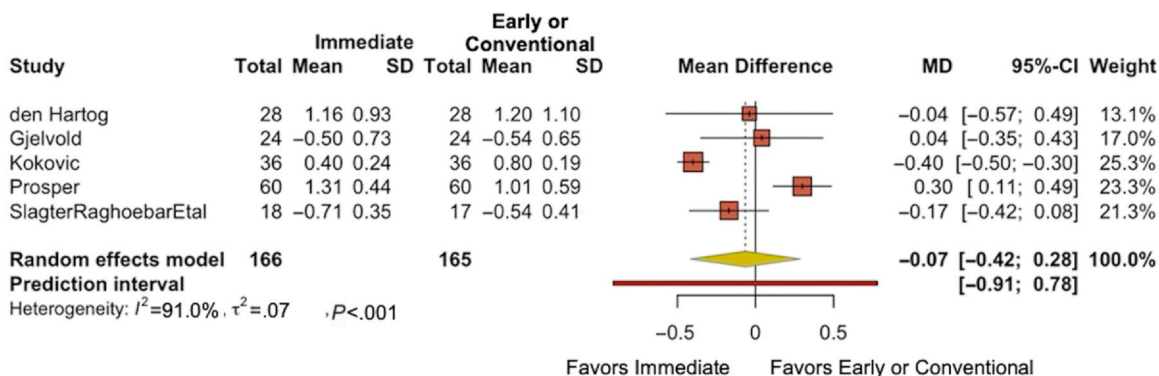


Figure 13. Forest plot comparing 5-year implant MBL between immediate and early or conventional loading. Mean Difference (MD) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

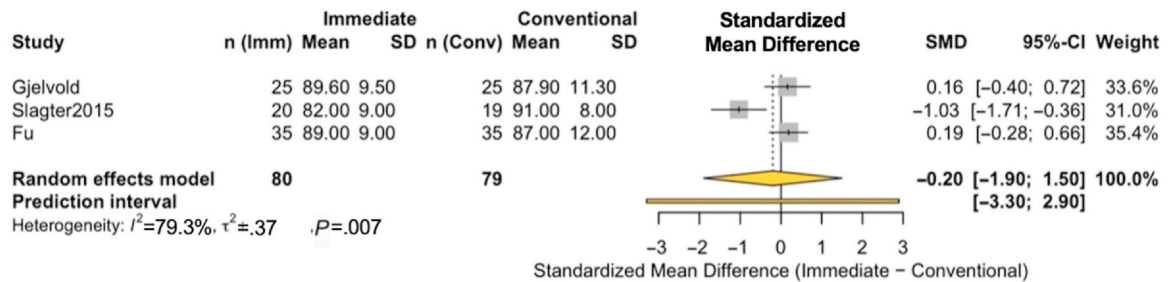


Figure 14. Forest plot comparing 1-year patient satisfaction between immediate and conventional loading. Standardized Mean Difference (SMD) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

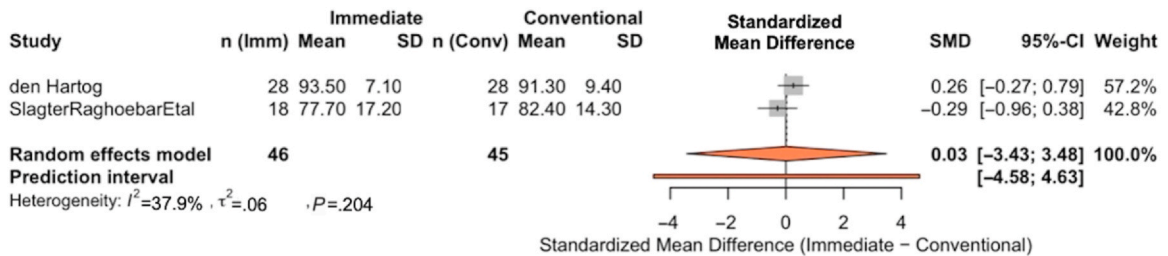


Figure 15. Forest plot comparing 5-year patient satisfaction between immediate and conventional loading. Standardized Mean Difference (SMD) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

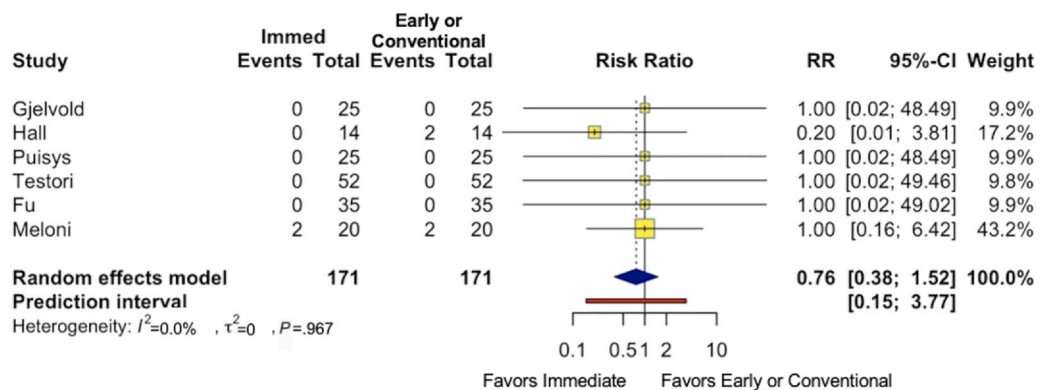


Figure 16. Forest plot comparing 1-year prosthetic complications between immediate and early or conventional loading. Risk ratios (RR) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

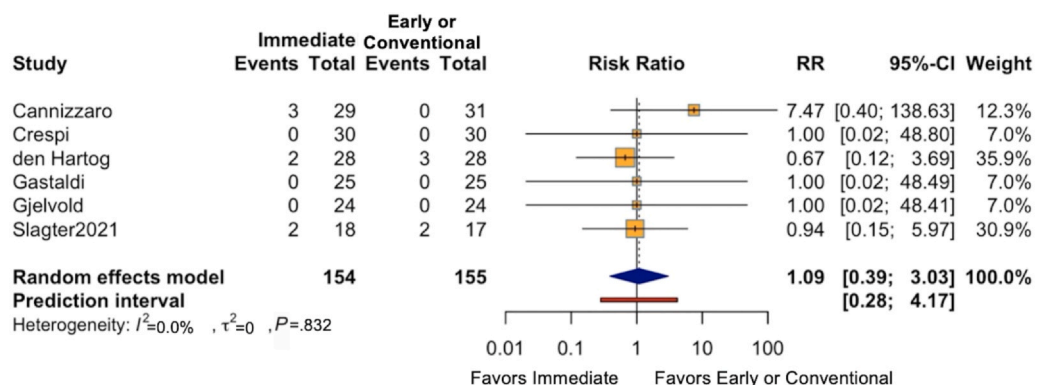


Figure 17. Forest plot comparing mid-term prosthetic complications between immediate and early/conventional(delayed) loading. Risk ratios (RR) and 95% confidence intervals (CI) displayed for each RCT and pooled using random-effects model.

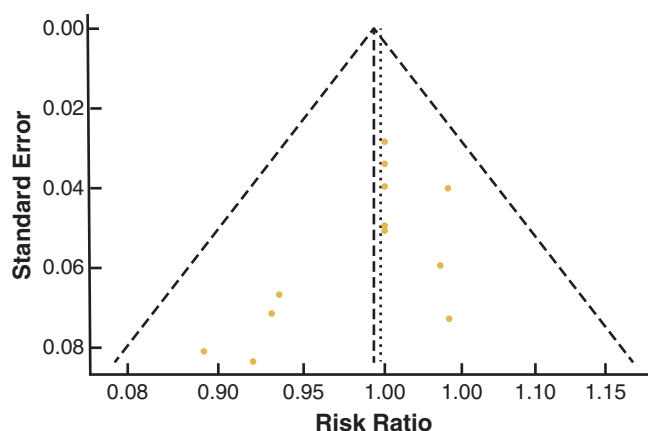


Figure 18. Funnel plot of included studies.

stability metrics, surgical and prosthetic protocols, and complications—aligned with PRIO-harms guidance—will strengthen the evidence base and clarify indications for safe immediate loading.

CONCLUSIONS

Based on the findings of this de novo RCT-level meta-analysis, the following conclusions were drawn:

1. Immediate loading of single implants demonstrated survival, marginal bone stability, complication rates, and patient satisfaction similar to early or conventional loading when applied under appropriate clinical conditions.
2. These findings suggested that loading timing alone is not the primary determinant of success; instead, careful patient selection, adequate primary stability, and meticulous surgical and prosthetic execution are paramount.

APPENDIX A. SUPPORTING INFORMATION

Supplemental data associated with this article can be found in the online version at [doi:10.1016/j.prosdent.2026.06.009](https://doi.org/10.1016/j.prosdent.2026.06.009).

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