International Platform of Registered Systematic Review and Meta-analysis Protocols

INPLASY

INPLASY2026110040

doi: 10.37766/inplasy2026.11.0040

Received: 11 November 2026

Published: 11 November 2026

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Clinical outcomes of immediate implant placement in fresh extraction sockets and implant placement after alveolar ridge preservation: a systematic review and meta-analysis of peri-implantitis, marginal bone loss, and implant failure

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ADMINISTRATIVE INFORMATION

Support - No support.

Review stage at the time of initial registration - Completed but not published.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2026110040

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 11 November 2026 and was last updated on 11 November 2026.

INTRODUCTION

Review question / Objective To estimate pooled peri-implantitis proportion, marginal bone loss (MBL), and implant failure for extraction-site implant pathways.

Condition being studied Patients receiving dental implants in fresh extraction sockets or after extraction-site management pooled peri-implantitis proportion, marginal bone loss (MBL), and implant failure.

METHODS

Participant or population Patients receiving dental implants in fresh extraction sockets or after extraction-site management.

Intervention Immediate placement, ARP-associated placement, grafted extraction-site pathways, or other extraction-site protocols.

Comparator Within-study comparator groups when available, although comparative treatment effects were not the primary estimand.

Study designs to be included Randomized or comparative trials, prospective or retrospective cohorts, cross-sectional analyses, and prospective case series.

Eligibility criteria (i) Enrolled patients receiving implants in fresh extraction sockets or after an extraction-site management pathway such as ARP; (ii) reported at least one eligible outcome—peri-implantitis as an event count/proportion, MBL as a mean with a measure of dispersion or data permitting its derivation, or implant failure as an event count with an implant denominator; (iii) had a minimum follow-up of 6 months; and (iv) used an eligible clinical design, including randomized/comparative trials, prospective or retrospective cohorts, cross-sectional analyses, or prospective case series.

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Information sources A comprehensive electronic search was performed in PubMed, Web of Science Core Collection, Scopus, and Embase from database inception to January 2026.

Main outcome(s) Peri-implantitis proportion (primary), MBL and implant failure (secondary).

Quality assessment / Risk of bias analysis Risk of bias was assessed uniformly across all 19 independent cohorts using the 10-item Hoy et al. prevalence-oriented tool. The items addressed target-population representativeness, sampling-frame representativeness, appropriate participant selection, non-response/attrition bias, direct data collection, clarity of the outcome definition, validity and reliability of measurement, consistency of measurement mode, appropriateness of the observation period, and appropriateness of the numerator and denominator. Each item was coded 0 for low risk and 1 for high risk. Total scores of 0–3, 4–6, and 7–10 were classified as low, moderate, and high overall risk of bias, respectively. Judgments were used to characterize internal and external validity of the single-arm outcome estimates rather than to generate a numerical study-quality weight. Summary and item-level judgments are presented in Table 2 and Supplementary Table S4, respectively.

Strategy of data synthesis All quantitative analyses were performed using Python 3.13.5 with statsmodels 0.14.6 and independently checked with explicit effect-size calculations. The primary synthesis used one effect estimate per independent cohort for each outcome. Random-effects pooling used the Paule–Mandel estimator for between-study variance (τ^2). Confidence intervals used the Hartung–Knapp t distribution with the variance factor constrained to at least 1 ($q^*=\max[1,QRE/(k-1)]$), thereby defining the modified Hartung–Knapp procedure used throughout. For peri-implantitis and implant failure, proportions were analyzed on the logit scale and back-transformed for presentation. A 0.5 continuity correction was applied only to zero- or all-event cohorts in the primary normal-approximation model. For MBL, raw means in millimeters were pooled with sampling variance SD^2/n. Here, k denotes the number of independent studies/cohorts contributing to an outcome.

Subgroup analysis Descriptive subgroup syntheses are shown in Figures S1–S3. By follow-up duration, peri-implantitis proportions were 12.0% (95% CI 4.2%–29.7%; k=5) at ≤60 months and 11.0% (95% CI 5.7%–20.3%; k=5) at >60 months; corresponding MBL means were 0.86 mm (95% CI 0.33–1.40; k=9) and 0.70 mm (95% CI 0.43–0.97; k=7), and implant-failure proportions were 3.7% (95% CI 2.7%–5.2%; k=11) and 2.8% (95% CI 1.2%–6.3%; k=7). Under the consistent pathway rule, peri-implantitis was 9.2% (95% CI 4.4%–18.3%; k=6) in immediate/fresh-socket cohorts and 14.5% (95% CI 5.1%–34.9%; k=4) in ARP/mixed cohorts. MBL was 0.61 mm (95% CI 0.33–0.90; k=11) versus 1.19 mm (95% CI 0.40–1.97; k=5), and failure was 3.5% (95% CI 2.1%–5.8%; k=13) versus 3.4% (95% CI 1.8%–6.4%; k=5), respectively. These strata are descriptive and do not estimate causal pathway effects.Descriptive subgroup syntheses considered follow-up duration (≤60 versus >60 months) and a consistently applied extraction-site pathway rule. Cohorts were classified as an immediate/fresh-socket pathway when the eligible cohort consisted of immediate placement without a protocolized delayed post-ARP component; cohorts containing protocolized ARP/delayed placement or an inseparable mixture of immediate and ARP pathways were classified as ARP/mixed. No eligible cohort was excluded from the pathway classification.

Sensitivity analysis Sensitivity analyses were consistent with the overall interpretation (Supplementary Table S7). Excluding the two cross-sectional peri-implantitis studies (Parvini 2020 and Buonocunto 2023) yielded 13.4% (95% CI 8.0%–21.6%; k=8; I^2=77.3%), and excluding Chou 2023, for which a minimum of 12 months in function was not established, yielded 10.4% (95% CI 6.3%–16.5%; k=9; I^2=75.5%). Restriction to one-implant-per-patient cohorts produced MBL of 0.55 mm (95% CI 0.14–0.96; k=7; I^2=97.0%) and failure of 3.8% (95% CI 2.0%–7.1%; k=9; I^2=0%). Peri-implantitis design-effect analyses at ICC values of 0.05, 0.10, and 0.20 yielded 11.51% (95% CI 7.01%–18.34%), 11.52% (7.01%–18.36%), and 11.55% (7.03%–18.40%), respectively. The binomial-normal GLMM, which used the original binomial counts without continuity correction, estimated failure at 2.2% (95% CI 1.2%–3.8%) with τ^2=0.289; thus the zero heterogeneity estimate from the continuity-corrected normal approximation did not persist under the exact binomial-normal model, although the absolute failure rate remained low. Leave-one-study-out and study-clustered arm-level analyses likewise did not alter the substantive conclusions (Figure 5).

Country(ies) involved China.

Keywords Dental Implants; Extraction Socket; Peri-Implantitis; Marginal Bone Loss; Implant Failure; Meta-Analysis.

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