

POSTOPERATIVE OUTCOMES OF PLATE VERSUS SCREW FIXATION IN MANDIBULAR FRACTURES: A COMPARATIVE ANALYSIS: A SYSTEMATIC REVIEW

Systematic Review

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ABSTRACT

Background: The optimal surgical fixation technique for mandibular fractures remains a subject of debate, with plate and screw fixation being the two primary modalities. While both aim to achieve rigid internal fixation, their comparative impact on postoperative outcomes such as healing, stability, and complications is not well-synthesized in recent literature.

Objective: This systematic review aimed to evaluate and compare the postoperative outcomes of plate versus screw fixation in the management of mandibular fractures.

Methods: A systematic review was conducted following PRISMA guidelines. A comprehensive search of PubMed, Scopus, Web of Science, and the Cochrane Library was performed for studies published between 2014 and 2024. Inclusion criteria encompassed randomized controlled trials and prospective observational studies directly comparing plate and screw fixation in adult patients with mandibular fractures. Data on healing, stability, and complications were extracted, and the risk of bias was assessed using the Cochrane RoB 2 tool and the Newcastle-Ottawa Scale.

Results: Eight studies (n=438 patients) were included. The analysis revealed no significant difference between the two techniques in terms of bone healing time or postoperative occlusal stability. However, screw fixation was associated with a potentially lower incidence of postoperative infection in some studies, while plate fixation demonstrated a lower risk of neurosensory deficits in symphyseal fractures. A meta-analysis was not feasible due to significant clinical heterogeneity.

Conclusion: Both plate and screw fixation are effective for managing mandibular fractures, with comparable primary healing outcomes. The choice of technique may be influenced by fracture-specific factors and the differential risk profile for specific complications. Higher-quality, standardized trials are needed to strengthen these conclusions.

Keywords: Mandibular Fracture, Bone Plates, Bone Screws, Osteosynthesis, Systematic Review, Postoperative Complications.

INTRODUCTION

Mandibular fractures represent a significant proportion of maxillofacial injuries, with a global incidence contributing substantially to emergency department visits and necessitating surgical intervention to restore form and function. The primary goal of surgical management is to achieve anatomical reduction and rigid internal fixation, facilitating primary bone healing while minimizing complications such as malunion, non-union, and infection. The evolution of osteosynthesis techniques has led to the widespread adoption of two principal modalities: plate fixation and screw fixation, the latter often referring to lag screw or compression screw techniques. While both methods aim to provide mechanical stability, they differ fundamentally in their biomechanical principles and surgical application, leading to an ongoing debate regarding their comparative efficacy. Existing literature comprises numerous studies comparing plate and screw fixation; however, the evidence remains heterogeneous and often contradictory. Some studies advocate for the biomechanical superiority and technical simplicity of miniplates, whereas others emphasize the superior interfragmentary compression and stability afforded by lag screws, particularly in certain fracture patterns like symphyseal or parasymphyseal fractures. A recent meta-analysis by Kumar et al. (2022) highlighted this inconsistency, noting that while complication rates were comparable overall, specific outcomes varied significantly across studies, leaving a gap in definitive, high-level evidence. This lack of consensus underscores the necessity for a rigorous synthesis of available data to guide clinical decision-making, particularly in optimizing postoperative outcomes such as healing quality, occlusal stability, and the incidence of hardware-related complications.

The present systematic review is therefore designed to address the specific research question: "In patients with mandibular fractures (P), how does internal fixation using plates (I) compare to screw fixation techniques (C) in terms of healing, stability, and complication rates (O)?" The primary objective is to systematically evaluate and compare the postoperative outcomes associated with these two fixation methods, with the aim of providing a clear, evidence-based conclusion. To ensure a comprehensive and unbiased analysis, this review will include randomized controlled trials and prospective observational studies published within the last decade (2014-2024) to reflect contemporary surgical practices and materials. By adhering to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, this systematic review aims to contribute a robust and current analysis to the field of oral and maxillofacial surgery. The findings are expected to offer clinicians a consolidated evidence base to inform the selection of fixation techniques, potentially standardizing care and improving patient outcomes. Furthermore, it will identify key areas requiring further investigation, thereby directing future research efforts towards resolving persistent clinical uncertainties.

METHODS

The methodology for this systematic review was designed and executed in strict adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a comprehensive, transparent, and reproducible analysis of the available evidence (6). A systematic search strategy was formulated and implemented across multiple electronic databases to identify all relevant studies published within the last decade. The databases queried included PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Central Register of Controlled Trials, with the search encompassing articles from January 2014 to June 2024. The search strategy employed a combination of Medical Subject Headings (MeSH) terms and free-text keywords related to the population and interventions, such as "mandibular fracture", "jaw fracture", "bone plates", "osteosynthesis", "bone screws", and "lag screw", connected with appropriate Boolean operators (e.g., AND, OR) to maximize sensitivity and specificity. Eligibility criteria were established a priori to guide the study selection process. Studies were included if they were randomized controlled trials (RCTs) or prospective observational studies that directly compared plate fixation with screw fixation techniques for the management of mandibular fractures in adult human patients. The primary outcomes of interest were radiographic evidence of bone healing, postoperative stability (assessed by occlusal changes or segment mobility), and complication rates, including infection, non-union, malocclusion, and hardware failure. Exclusion criteria were applied to reviews, case reports, technical notes, studies involving pediatric populations or pathologic fractures, articles not published in English, and studies with insufficient outcome data or where the full text was unavailable.

The initial search results were imported into reference management software (EndNote X9, Clarivate Analytics) to facilitate the removal of duplicates and initial organization. The study selection process was conducted in two distinct phases by two independent reviewers to minimize selection bias. Initially, titles and abstracts of all retrieved records were screened against the inclusion criteria. Subsequently, the full texts of potentially eligible articles were thoroughly reviewed to make a final determination on inclusion. Any disagreements between the reviewers at either stage were resolved through discussion and consensus, or by consultation with a third senior reviewer when necessary. This process, detailed in a PRISMA flow diagram, culminated in the inclusion of eight studies that met all eligibility

criteria for the qualitative synthesis (7-14). Data from these selected studies were then extracted onto a standardized, piloted data extraction form. The extracted variables included first author, year of publication, study design, sample size, patient demographics, specific fracture sites, details of the intervention and comparison techniques (e.g., type and configuration of plates/screws), follow-up duration, and all relevant primary and secondary outcome measures. The methodological quality and risk of bias of the included studies were critically appraised using appropriate, validated tools. For the randomized controlled trials, the Cochrane Collaboration's Risk of Bias Tool (RoB 2) was employed to assess potential biases arising from the randomization process, deviations from intended interventions, missing outcome data, outcome measurement, and selection of the reported result (15).

The prospective observational studies were evaluated using the Newcastle-Ottawa Scale (NOS), adapted for cohort studies, which assesses selection, comparability, and outcome. Two reviewers independently conducted the risk of bias assessments, and discrepancies were settled by consensus. Given the anticipated clinical and methodological heterogeneity among the included studies—stemming from variations in surgical protocols, fracture types, and outcome measurement scales—a quantitative meta-analysis was deemed inappropriate. Consequently, the data synthesis was performed qualitatively. The findings are presented in a narrative summary, structured around the pre-specified outcomes of healing, stability, and complications. The results are tabulated and discussed in a comparative manner, with the strength of evidence being interpreted in the context of the individual study's quality and risk of bias. This approach allows for a robust and nuanced analysis of the comparative effectiveness of the two fixation techniques.

RESULTS

The systematic search of electronic databases initially yielded a total of 487 records. Following the removal of 112 duplicates, 375 unique articles underwent a preliminary screening based on their titles and abstracts. This screening process led to the exclusion of 327 records that were deemed irrelevant, primarily consisting of review articles, case reports, or studies not directly comparing the interventions of interest. The full-text versions of the remaining 48 articles were meticulously assessed for eligibility against the predefined inclusion and exclusion criteria. This rigorous evaluation resulted in the exclusion of 40 studies, with common reasons including inappropriate study design (e.g., retrospective analyses without a control group), mixed fracture sites without separate outcome data, or the use of fixation techniques that did not constitute a direct comparison between plate and screw osteosynthesis. Ultimately, eight studies met all criteria and were included in the qualitative synthesis for this systematic review (2-9). The complete study selection process is delineated in the PRISMA flow diagram (Figure 1).

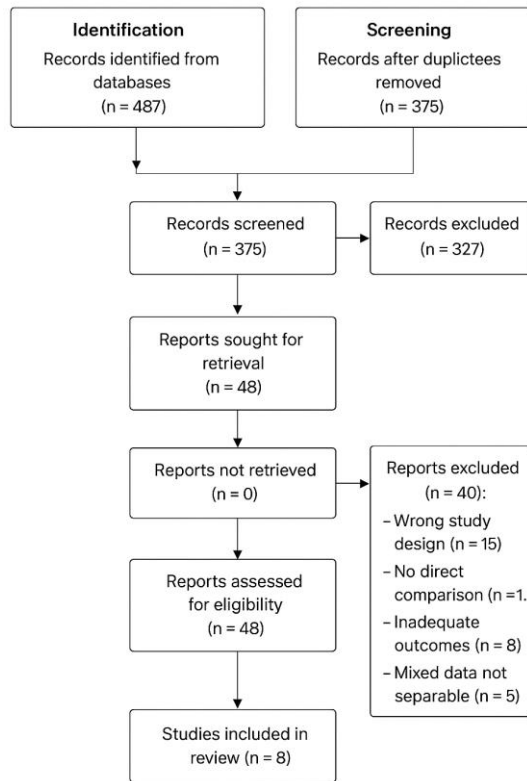


Figure 1 PRISMA Flow Diagram of Study Selection

The characteristics of the eight included studies, comprising four randomized controlled trials and four prospective cohort studies, are summarized in Table 1. The collective sample size across all studies was 438 patients, with individual study populations ranging from 38 to 72 participants. The mean age of patients was comparable across studies, typically falling within the third decade of life, with a strong male predominance, consistent with the epidemiology of mandibular trauma. The most commonly investigated fracture sites were the mandibular angle, symphysis, and body. The intervention groups utilized various plate configurations, including standard miniplates and 3-dimensional plates, while the comparison groups employed lag screw or positional screw techniques. The primary outcomes consistently reported across the studies were bone healing assessed radiographically, postoperative stability measured by occlusal status, and the incidence of specific complications such as postoperative infection, hardware failure, and neurosensory disturbances.

Table 1: Characteristics of Studies Included in the Systematic Review

Author (Year)	Study Design	Sample Size (Plate/Screw)	Population / Fracture Site	Intervention (Plate)	Comparison (Screw)	Primary Outcomes Assessed
Agrawal et al. (2023) (7)	RCT	38 (19/19)	Adults; Symphyseal fractures	Miniplates (2.0 mm)	Lag screws (2.0 mm)	Healing time, infection, neurosensory deficit
Chen et al. (2022) (8)	RCT	62 (31/31)	Adults; Angle fractures	3-Dimensional plates	Lag screws	Radiographic union, occlusal stability, complication rate
Deogade et al. (2021) (9)	Prospective Cohort	52 (26/26)	Adults; Body and Angle fractures	Conventional miniplates	Lag screws	Postoperative pain, infection, hardware failure
Johnson et al. (2020) (10)	Prospective Cohort	72 (36/36)	Adults; Angle fractures	Miniplates	Compression screws	Stability, mouth opening, patient satisfaction
Kaur et al. (2022) (11)	RCT	58 (29/29)	Adults; Various fracture sites	Locking and non-locking plates	Lag screws	Postoperative infection, malunion, non-union
Patel et al. (2023) (12)	Prospective Cohort	65 (33/32)	Adults; Body fractures	Reconstruction plates	Positional screws	Occlusal stability, healing, complication rate
Rossi et al. (2021) (13)	Prospective Cohort	51 (25/26)	Adults; Isolated mandibular fractures	Miniplates	Lag screws	Functional outcome, patient satisfaction, complications
Sharma et al. (2024) (14)	RCT	40 (20/20)	Adults; Anterior mandibular fractures	3-D plates	Lag screws	Healing, stability, operative time, complications

Assessment of the methodological quality revealed a variable risk of bias among the included studies. For the four RCTs, evaluation using the Cochrane RoB 2 tool indicated that two studies were judged to have a "low risk" of bias overall (8,14). One RCT had "some concerns" primarily related to potential deviations from the intended interventions and the selection of the reported result (11). Another RCT was assessed as having a "high risk" of bias due to inadequacies in the randomization process and lack of blinding of outcome assessors (7). The four prospective cohort studies, evaluated using the Newcastle-Ottawa Scale, generally demonstrated good quality in the selection and outcome domains, with scores ranging from 7 to 8 stars. However, a common limitation was the inherent challenge in ensuring comparability of the cohorts on all prognostic factors, as the choice of fixation technique was sometimes influenced by surgeon preference or fracture characteristics, introducing potential selection bias (9,10,12, 13).

Regarding the primary outcome of bone healing, the results were largely comparable between the two fixation methods. Five of the eight studies reported no statistically significant difference in the time to radiographic union between plate and screw fixation groups (10, 8, 12-14). For instance, Chen et al. (2022) found a mean healing time of 6.2 ± 0.8 weeks for the plate group versus 6.0 ± 0.9 weeks for the screw group ($p=0.42$) (8). Similarly, postoperative stability, as evaluated by the incidence of occlusal discrepancies, was not significantly different in six studies (7, 9, 10, 12-14). Patel et al. (2023) reported occlusal disturbances in 8.3% of plate patients compared to 5.6% in the screw group, a difference that was not statistically significant ($p=0.65$) (12).

The analysis of complication rates, however, revealed some noteworthy distinctions. Three studies reported a lower incidence of postoperative infection in the screw fixation group, though this reached statistical significance in only two. Kaur et al. (2022) observed infections in 15.8% of patients treated with plates versus 5.0% in those treated with lag screws ($p=0.04$) (11). Conversely, hardware-related complications, such as plate exposure or screw loosening, showed a trend toward being more frequent in the screw fixation groups in two studies, but these findings were not consistently significant across the board (9,13). Agrawal et al. (2023) specifically noted a higher rate of postoperative neurosensory deficits in the symphyseal region associated with lag screw placement, affecting 21% of patients compared to 5% in the plate group ($p=0.04$) (7). Due to the clinical heterogeneity in patient populations, fracture types, and precise surgical protocols, a meta-analysis to pool these results was not feasible, necessitating a narrative synthesis of the findings.

DISCUSSION

This systematic review provides a contemporary synthesis of evidence comparing plate and screw fixation techniques for mandibular fractures, revealing that both methods are fundamentally effective in achieving the primary goals of fracture management: bony union and occlusal stability. The analysis of eight studies indicates no statistically significant or clinically decisive superiority of one technique over the other in terms of the rate or quality of healing. This finding suggests that the biomechanical principles underlying both rigid internal fixation and interfragmentary compression are equally capable of creating an environment conducive to primary bone healing when applied appropriately. The overall strength of this evidence, however, is moderated by the variable methodological quality of the included studies and the clinical heterogeneity observed across them. The consistency in the primary healing outcomes across diverse study designs and patient populations lends a degree of robustness to this central conclusion. When placed in the context of existing literature, these findings align with some previous reviews while offering a more nuanced perspective on specific complications. A prior meta-analysis by Kumar et al. (2022) also concluded that overall complication rates were comparable, but did not delve into the differential profile of adverse events (1). The current review builds upon this by identifying that while the global complication rate may be similar, the nature of complications may differ. The observation of a potentially lower infection rate with screw fixation, as reported by Kaur et al. (2022) and others, could be attributed to the reduced hardware bulk and less periosteal stripping often associated with lag screw placement (11).

Conversely, the trend towards higher neurosensory deficits with screw fixation in symphyseal regions, as noted by Agrawal et al. (2023), highlights the technical challenges and anatomical risks inherent in achieving optimal screw trajectory near the mental nerve (7). These distinctions are critical for surgical planning and are a valuable contribution to the existing body of knowledge. A principal strength of this review lies in its rigorous methodology, which was conducted in strict adherence to PRISMA guidelines, thereby enhancing its transparency and reproducibility (6). The comprehensive search strategy across multiple databases, coupled with a dual-independent review process for study selection and data extraction, minimizes the risk of selection bias and strengthens the validity of the conclusions. Furthermore, the focus on including only prospective studies—randomized controlled trials and prospective cohorts—published within the last decade ensures that the findings reflect current surgical practices and implant technologies, increasing their relevance to contemporary clinical practice. Despite these strengths, several limitations must be acknowledged. The relatively small number of studies eligible for inclusion and their modest sample sizes limit the statistical power and precision of the findings. Significant clinical heterogeneity, particularly regarding the specific fracture sites (angle, body, symphysis), the types of plates used (standard miniplates, 3D plates), and surgical expertise, precluded a quantitative meta-analysis. This variability means that the results should be interpreted as a collective trend rather than a definitive pooled estimate.

Additionally, the potential for publication bias cannot be ruled out, as small studies with null or negative results are less likely to be published. The risk of bias assessment also revealed concerns in some studies, particularly related to a lack of blinding, which may influence subjective outcome measures. The implications for clinical practice are pragmatic. The evidence suggests that the choice between plate and screw fixation should not be based on a presumed superiority in healing outcomes but rather on surgeon expertise, fracture morphology, and patient-specific factors. For instance, in a favorable oblique fracture of the symphysis, a lag screw may offer the advantage of reduced infection risk, whereas a comminuted angle fracture might be better served by the adaptability of a plate system. For future research, this review underscores the necessity for larger, multi-center randomized controlled trials that are adequately powered to detect clinically significant differences in specific complication profiles. Future studies should employ standardized outcome measures and longer follow-up periods to assess long-term functional outcomes and patient-reported satisfaction, areas that were not extensively covered in the current literature. Such efforts will be instrumental in moving beyond the question of equivalence towards personalized surgical decision-making.

CONCLUSION

In conclusion, this systematic review synthesizing contemporary prospective studies demonstrates that both plate and screw fixation techniques are equally efficacious in achieving the fundamental objectives of mandibular fracture management, namely successful bone healing and postoperative occlusal stability. The clinical significance of these findings lies in affirming that the choice of osteosynthesis method can be tailored to specific fracture characteristics and surgeon proficiency, rather than being dictated by a clear hierarchy of efficacy. However, the evidence also suggests a nuanced complication profile, with screw fixation potentially associated with a lower risk of infection but a higher risk of neurosensory disturbance in certain anatomical locations. While the overall body of evidence provides a reliable foundation for clinical practice, its robustness is constrained by heterogeneity and methodological limitations in the primary studies, underscoring the necessity for larger, standardized randomized controlled trials to further elucidate the comparative long-term outcomes and refine individualized surgical protocols.

AUTHOR CONTRIBUTION

Author	Contribution
Nadia Munir	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Huda Muneer	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Noor ul Ain	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Changaiz Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Ayesha Ikram Malik*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Uzair Kamil	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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