

Interventions for treating olecranon fractures in adults: Protocol for a systematic review and meta-analysis of randomized controlled trials

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Abstract

Background: Olecranon fractures are prevalent elbow injuries in adults, often necessitating surgical intervention. While the tension band wiring technique is widely employed, it is associated with a high rate of complications. The current body of evidence includes a significant number of new studies published since the last comprehensive Cochrane review in 2014, highlighting a critical need for an updated and thorough synthesis of evidence to compare the effectiveness and safety of available treatment options.

Objective: This systematic review aims to identify, evaluate, and compare the effectiveness of different treatment options, including conservative and surgical approaches, for adult olecranon fractures, focusing on reducing complications, improving functional outcomes, and patient satisfaction.

Methods: This systematic review and meta-analysis protocol is designed according to the Cochrane Handbook for Systematic Reviews of Interventions and will be reported following the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. The final systematic review results will be reported according to the PRISMA 2020 guidelines. We will include randomized controlled trials (RCTs) evaluating any type of treatment for acute olecranon fractures in adults. Comprehensive searches will be conducted in major electronic databases, including PubMed, the Cochrane Library, EMBASE, LILACS, and SciELO, up to December 2025. Two independent reviewers will screen studies for eligibility, extract data using a pre-piloted, standardized form, and assess the risk of bias using the Risk of Bias 2 (RoB 2) tool. Primary outcomes will include functional assessment scores (e.g., MEPS, DASH) and adverse events (e.g., reoperation, infection, implant prominence). Secondary outcomes will encompass range of motion, pain, patient satisfaction, radiographic healing, and economic outcomes. A random-effects model will be used for meta-analysis when appropriate, with heterogeneity assessed by I^2 . Subgroup and sensitivity analyses will explore factors such as age, fracture classification, and type of intervention. The certainty of evidence will be assessed using the GRADE approach.

Results: As of September 2025, preliminary searches and selection of articles have been conducted. However, comprehensive database searches are planned to be repeated and finalized by December 2025 to ensure the inclusion of the most recent studies. The full systematic review is projected to be completed by July 29, 2026.

Conclusions: This systematic review will provide a robust synthesis of the current evidence on treatments for adult olecranon fractures. The findings are expected to clarify the comparative effectiveness and safety of various interventions, thereby informing clinical practice, guiding shared decision-making between patients and clinicians, and identifying key areas for future research and randomized controlled trials. Clinical Trial: PROSPERO CRD42024520697

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Original Manuscript

Interventions for treating olecranon fractures in adults: Protocol for a systematic review and meta-analysis of randomized controlled trials

Registration: PROSPERO - CRD42024520697

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Contributions: This protocol was developed by the main author, Daniel Andrade, with methodological and conceptual contributions from Marcel Jun Tamaoki and João Carlos Belloti, as well as Jorge Sayum. Marcel Jun Tamaoki, who also serves as the project's advisor, acts as the review guarantor, ensuring the integrity and compliance of the study with established standards for systematic reviews.

Amendments: This protocol is original, and as such, any modifications or amendments will be documented systematically. The documentation will include the date of the amendment, a detailed description of the changes made, and the rationale behind these changes. All amendments will be reviewed and approved by all authors, before implementation to maintain the integrity of the review process

Support

- **Sourcers:** This review is supported by institutional resources provided by the Universidade Federal de São Paulo (UNIFESP), which includes access to academic literature and facilities necessary for the conduct of this systematic review
- **Sponsors:** No external sponsor or financial support has been received for this systematic review.
- **Role of sponsor/funder:** Not applicable

ABSTRACT

Background: Olecranon fractures are prevalent elbow injuries in adults, often necessitating surgical intervention. While the tension band wiring technique is widely employed, it is associated with a high rate of complications. The current body of evidence includes a significant number of new studies published since the last comprehensive Cochrane review in 2014, highlighting a critical need for an updated and thorough synthesis of evidence to compare the effectiveness and safety of available treatment options.

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Conclusions: This systematic review will provide a robust synthesis of the current evidence on treatments for adult olecranon fractures. The findings are expected to clarify the comparative effectiveness and safety of various interventions, thereby informing clinical practice, guiding shared decision-making between patients and clinicians, and identifying key areas for future research and

randomized controlled trials.

Trial Registration: PROSPERO CRD42024520697

Keywords: Olecranon Process; Elbow Fractures; Fracture Fixation; Systematic Review; Randomized Controlled Trials; Adults; Complications; Treatment Outcome.

Word count: 3300

Article Summary:

Strengths and limitations of this study

- This systematic review protocol follows the guidelines of the Cochrane Handbook, PRISMA, and is registered in PROSPERO.
- This review will only include randomized controlled trials (RCTs), ensuring methodological rigor and robust evidence synthesis.
- Study selection, data extraction, and assessment of methodology will be conducted independently by two authors.
- The inclusion of diverse treatment modalities might introduce heterogeneity in the analysis, so subgroup analyses will be conducted to provide clearer insights.

INTRODUCTION

Olecranon fractures are a common elbow injury, accounting for approximately 18% of proximal forearm fractures, with an incidence of 12 per 100,000 per year (1). These fractures are more prevalent in patients over 65 years old, predominantly in women, who represent 65% of all cases in this age group (2).

Regarding the severity and classification of olecranon fractures, the most common type is the displaced fracture with a simple fracture pattern, classified as Mayo type 2A (3). These fractures are generally managed surgically, with the tension band technique being the most commonly used in this situation. However, this technique has been associated with a high rate of complications, including implant prominence, soft tissue irritation and reoperation (4). This significant complication profile has driven a series of studies exploring alternative surgical fixation methods, such as plating, transosseous sutures, and intramedullary screws, as well as the re-evaluation of conservative treatment for fractures previously considered classic indications for surgery

A 2014 Cochrane systematic review, 'Surgical interventions for treating fractures of the olecranon in

adults' (5), highlighted the insufficiency of robust evidence regarding available surgical interventions and notably exclusively analyzed surgical treatments. Since its publication, a considerable number of new randomized controlled trials (RCTs) have emerged. These recent investigations often compare various surgical techniques against each other, or surgical interventions with conservative management, specifically seeking approaches that offer superior functional outcomes, a lower complication rate, and greater patient satisfaction across diverse patient populations and fracture patterns. (6–16). Furthermore, since its publication, comprehensive systematic reviews comparing both conservative and surgical approaches exclusively based on randomized controlled trials have remained scarce, often incorporating diverse study designs or presenting narrative syntheses, thereby limiting their quality of evidence for clinical decision-making.

Therefore, an updated, comprehensive synthesis of the current evidence is critically needed. This is particularly relevant given the proliferation of new articles on the topic, the persistent lack of consensus regarding the optimal approach to treating olecranon fractures in adults, and the increasing focus on patient-centered outcomes and complication reduction.

The objective of this systematic review is to comprehensively identify, evaluate, and compare the effectiveness and safety of all available treatment options, including both conservative and surgical approaches, for adult olecranon fractures. We aim to synthesize evidence on key patient-important outcomes such as functional assessment scores, adverse events, pain, and patient satisfaction, providing a robust evidence base for clinical decision-making.

METHODS AND ANALYSIS

Inclusion and exclusion criteria:

Study Design: Only randomized controlled trials (RCTs) comparing any type of treatment for olecranon fractures in adults will be included.

Population (P): Studies involving adult patients aged 18 years or older, of any race or gender, presenting with acute olecranon fractures will be included. For clarity, acute fractures are defined as those occurring within three weeks of injury.

Interventions (I) and Comparators (C): Any type of treatment for olecranon fractures will be considered, encompassing both surgical and non-surgical approaches. Surgical interventions may include, but are not limited to, tension band wiring (TBW), plate fixation (e.g., locking plates, non-locking plates), intramedullary screw fixation, and transosseous sutures. Non-surgical approaches may include casts, splints, slings, and early mobilization protocols. Comparisons may be conducted between different surgical

techniques, between different non-surgical methods, or between surgical and non-surgical treatments.

Outcomes (O): Studies reporting on any of the predefined primary or secondary outcomes, as detailed in the "Outcomes" section, will be considered eligible.

Exclusion Criteria: Studies will be systematically excluded if they do not meet the aforementioned inclusion criteria. Specifically, the following will be excluded:

- Non-randomized study designs (e.g., observational studies, case series, cohort studies, case reports).
- Studies focused on pediatric populations (patients younger than 18 years).
- Studies exclusively investigating pathological fractures, non-union, or revision surgeries.
- *In vitro* studies, animal studies, editorials, commentaries, letters to the editor, expert opinions, or other non-primary research articles.
- Systematic reviews or meta-analyses (although their reference lists will be screened for eligible RCTs).
- Studies not published as full-text articles (e.g., conference abstracts without full-text availability, unpublished trials without accessible results).
- Studies where the primary intervention or outcome is not directly related to the treatment of an olecranon fracture (e.g., studies primarily focusing on associated complex elbow injuries where the olecranon fracture is secondary).

Outcomes: The selection of outcomes for this systematic review is guided by clinical relevance and the likelihood of being reported in randomized controlled trials concerning olecranon fractures. Outcomes will be classified as primary and secondary.

Primary Outcomes:

1. **Functional Assessment:** This will be evaluated using validated, patient-reported, upper limb-specific clinical scores. Examples include the Mayo Elbow Performance Score (MEPS), the Disabilities of the Arm, Shoulder and Hand (DASH) score, and the Oxford Elbow Score. (17–19)
2. **Adverse Events:** These will encompass all complications reported in the included studies. Specific focus will be given to reoperations (e.g., for hardware removal, revision surgery), infection (superficial and deep), implant-related complications (e.g., implant prominence, migration, failure), and loss of reduction.
3. **Pain Intensity:** Assessed using validated scales, such as the Visual Analogue Scale (VAS) or

Numeric Rating Scale (NRS), as reported in the individual studies.

Secondary Outcomes:

1. **Range of Motion (ROM) of the Elbow:** Objective measurements of active elbow flexion, extension, pronation, and supination.
2. **Patient Satisfaction:** This outcome will be captured through patient-reported questionnaires or specific items within broader quality of life scales, including assessment of aesthetic results where reported.
3. **Radiographic Outcomes and Consolidation Rates:** Evaluation of fracture union, anatomical reduction, alignment, and any radiological signs of implant failure or malunion.
4. **Intraoperative Metrics:** This includes operation time and estimated blood loss.
5. **Economic Outcomes:** Any reported data related to direct and indirect costs of treatment, as well as cost-effectiveness analyses.

Timing of Outcome Assessment: Outcomes will be collected at all time points reported by the included studies. Special attention will be given to short-term (up to 3 months), medium-term (3 to 12 months), and long-term (beyond 12 months) follow-up periods.

Search Strategy: A comprehensive and systematic search will be conducted to identify all relevant randomized controlled trials (RCTs). This search will be meticulously developed in consultation with an experienced librarian to ensure optimal sensitivity and specificity. The following electronic databases will be systematically searched from their inception up to December 2025: PubMed/MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL), SciELO (Scientific Electronic Library Online), and LILACS via Biblioteca Virtual em Saúde (BVS).

To complement these database searches and minimize publication bias, sources of grey literature and clinical trial registries will also be consulted. These will encompass ClinicalTrials.gov, the World Health Organization International Clinical Trials Registry Platform (WHO ICTRP), and OpenGrey.

The search strategy for each database will combine controlled vocabulary terms (e.g., Medical Subject Headings [MeSH] for PubMed, Emtree terms for EMBASE) with free-text terms (keywords) related to the population ("olecranon fracture" and its synonyms) and the interventions (surgical and non-surgical treatments). Boolean operators ('AND', 'OR') will be used to combine these terms effectively. Validated methodological filters, specifically designed to identify RCTs and recommended by the Cochrane Handbook for Systematic Reviews of Interventions, will be applied to each database.

For full transparency and reproducibility, the complete and specific search strategy for each

database, detailing the exact syntax, all search terms, Boolean operators, and applied filters, is provided in a dedicated Appendix A. Additionally, the reference lists of all included studies and relevant systematic reviews will be manually screened for additional eligible RCTs.

Selection process: Two reviewers (Daniel Andrade and Jorge Sayum) will independently perform a two-stage screening of studies using the Covidence software (Veritas Health Innovation, Melbourne, Australia), developed in collaboration with Cochrane. In the first stage, titles and abstracts will be screened and studies categorized as “yes,” “no,” or “maybe” for inclusion. Records marked as “yes” or “maybe” will progress to the second stage, full-text screening. During full-text review, reviewers will independently assess eligibility and provide a specific reason for exclusion, if a study is excluded. All reasons for exclusion at the full-text stage will be recorded and managed within Covidence, facilitating transparent documentation consistent with PRISMA 2020 guidelines. Discrepancies between reviewers at either stage will be resolved by discussion or, if necessary, by adjudication from a third reviewer (Marcel Jun Tamaoki). Corresponding authors of studies lacking essential data will be contacted for clarification. Studies that remain without sufficient information after these attempts will be flagged accordingly.

Data extraction: Data extraction will be conducted independently by two reviewers (Daniel Andrade and Jorge Sayum). This process will utilize the dedicated data extraction module within Covidence software. A standardized and pre-piloted data extraction form will be designed and configured within the software to ensure comprehensive and consistent data capture. This form will specifically include the data items detailed in the subsequent ‘Data Items’ section, developed to directly address the review’s objectives and research questions.

Prior to full-scale extraction, the form will be rigorously piloted on a subset of included studies. Refinements will be made as necessary during this piloting phase to optimize its comprehensiveness and ease of use. Discrepancies identified during data extraction will be resolved through discussion and consensus between the two independent reviewers. If an agreement cannot be reached, a third reviewer (Marcel Jun Tamaoki) will adjudicate to ensure a final decision.

All extracted data will be securely stored within Covidence, ensuring data integrity, version control, and restricted access to the review team. Upon completion of data extraction and resolution of all discrepancies, the final dataset will be exported for statistical analysis.

Data items: The following data items will be extracted from included studies:

- **Study Identification and Characteristics:**
 - Study title and primary authors
 - Publication year and journal.

- Country and clinical setting
- Study design
- Duration of the study, including recruitment period and follow-up length.
- Funding sources and declared conflicts of interest.
- **Participant Characteristics:**
 - Inclusion and exclusion criteria of the study.
 - Total number of participants randomized and analyzed per group.
 - Baseline demographics (mean age, age range, sex distribution, relevant comorbidities).
 - Specific details of the olecranon fractures, including diagnostic criteria and classification systems utilized
 - Losses to follow-up and reasons for attrition.
- **Intervention Details:**
 - Detailed description of the interventions for each study arm
 - Comparison group details.
 - Duration and frequency of the intervention.
 - Details of co-interventions or concomitant treatments
 - Qualifications of personnel administering the interventions, if reported.
- **Outcome Data:**
 - **Primary Outcomes:**
 - Functional assessment scores (e.g., MEPS, DASH, Oxford Elbow Score).
 - Adverse events
 - Pain intensity (e.g., VAS, NRS).
 - **Secondary Outcomes:**
 - Range of Motion (ROM) of the elbow (flexion, extension, pronation, supination).
 - Patient satisfaction (including aesthetic results, if assessed).
 - Radiographic outcomes
 - Intraoperative metrics (e.g., operation time, estimated blood loss).
 - Economic outcomes (e.g., cost-effectiveness, direct/indirect costs).

- For all outcomes, relevant statistics will be extracted, including sample sizes, means, standard deviations, medians, interquartile ranges, counts of events, and measures of effect (e.g., mean differences, risk ratios) with their respective confidence intervals and p-values, at all reported time points. Outcome data will be captured with time points as reported by the included studies. Additional outcome details such as measurement scales, units, directionality, and actual reported values will be extracted to ensure comparability and robust synthesis. Secondary outcomes such as range of motion, patient satisfaction, radiographic healing, and economic evaluations will be included as reported on a case-by-case basis.
- **Methodological Details for Risk of Bias Assessment:** Information required for assessing bias in each domain of the RoB 2 tool (details on randomization process, allocation concealment, blinding, handling of missing data, selective reporting).

Data Synthesis Strategy: When appropriate and feasible, results from comparable groups across the included studies will be pooled if participants, interventions, comparisons, and outcomes are sufficiently similar. All meta-analyses will be conducted using Review Manager 5.4/Rev.Man web software. It is anticipated that the underlying effect of the intervention may vary among the studies due to likely differences in participants, settings, and interventions. Therefore, a random-effects model will be employed for the meta-analysis. Estimated effects will be expressed as the number needed to treat (NNT) (20) when applicable. For dichotomous data, treatment differences will be analyzed as risk ratios (RR) using the Mantel-Haenszel method (21). For continuous outcomes, if all data are on the same scale, mean follow-up values will be pooled with change-from-baseline data, and results will be reported as the mean difference. Should there be a need to report standardized mean differences, the review authors will not pool endpoint and change-from-baseline data. If the included studies do not allow for data pooling, the results will be presented in a narrative format.

Risk of Bias in individual studies: The risk of bias of the included studies will be independently assessed by Daniel Andrade and Jorge Sayum using the Risk of Bias 2 (RoB 2) tool (22). This assessment will be conducted for all predefined primary and secondary outcomes. The evaluation will encompass the following five methodological domains: 1. Bias arising from the randomization process 2. Bias due to deviations from the intended interventions 3. Bias due to missing outcome data 4. Bias in measurement of the outcome 5. Bias in selection of the reported

result. Each domain will be assigned a judgment of 'low' risk of bias, 'high' risk of bias, or 'some concerns'. The 'some concerns' judgment will reflect a lack of information or uncertainty regarding the potential for bias. Any disagreements between the review authors regarding the risk of bias for each domain will be resolved by discussion or, if necessary, by Marcel Jun Tamaoki.

Assessment of Reporting Biases (Meta-biases): Reporting biases, including publication bias and selective reporting, will be systematically assessed to ensure the robustness of the synthesized evidence, in accordance with PRISMA-P 2015 (23) and the Cochrane Handbook (24). Proactively, our comprehensive search strategy includes grey literature and clinical trial registries (ClinicalTrials.gov, WHO ICTRP, OpenGrey) to minimize publication bias by identifying unpublished studies. For meta-analyses comprising a sufficient number of studies (typically ten or more), the presence of publication bias across studies will be visually inspected using funnel plots. If asymmetry is suggested by visual inspection, statistical tests such as Egger's regression test (25) or Begg's rank correlation test (26) will be employed to formally assess the likelihood of such biases. Furthermore, selective outcome reporting within individual studies will be evaluated as part of the Risk of Bias 2 (RoB 2) tool assessment, specifically under domain 5: "Bias in selection of the reported result."

Assessment of Reporting Biases (Meta-biases): Reporting biases, including publication bias and selective reporting, will be systematically assessed to ensure the robustness of the synthesized evidence, in accordance with PRISMA-P 2015 (23) and the Cochrane Handbook (24). Proactively, our comprehensive search strategy includes grey literature and clinical trial registries (ClinicalTrials.gov, WHO ICTRP, OpenGrey) to minimize publication bias by identifying unpublished studies. For meta-analyses comprising a sufficient number of studies (typically ten or more), the presence of publication bias across studies will be visually inspected using funnel plots. If asymmetry is suggested by visual inspection, statistical tests such as Egger's regression test (25) or Begg's rank correlation test (26) will be employed to formally assess the likelihood of such biases. Furthermore, selective outcome reporting within individual studies will be evaluated as part of the Risk of Bias 2 (RoB 2) tool assessment, specifically under domain 5: "Bias in selection of the reported result."

Assessment of heterogeneity: The statistical heterogeneity among the included trials will be evaluated by visually inspecting the forest plots and statistically assessed using the Chi² test for heterogeneity along with the I² statistic (24,27). The Chi² test p-value will be considered significant at $p < 0.10$. Heterogeneity will be quantified and categorized based on I² values as follows: 0% to 40% may be considered as not important heterogeneity; 30% to 60% as moderate heterogeneity; 50%

to 90% as substantial heterogeneity; and 75% to 100% as considerable heterogeneity. It is important to note that these thresholds are guidelines rather than absolute cutoffs; the interpretation of I^2 values should also consider the magnitude and direction of effects, the p-value from the Chi^2 test, and the clinical context of the included studies.

Sensitivity analysis: The review authors plan to conduct sensitivity analyses to explore the robustness of the treatment effects on crucial outcomes. These analyses will assess the impact of including studies with high or unclear risks of detection, selection, and attrition biases, as well as the influence of studies with imputed data. Additionally, a sensitivity analysis will be conducted by excluding studies of lower methodological quality, as defined during the risk of bias assessment.

Subgroup Analysis: Subgroup analysis will be conducted based on the types of intervention (surgical vs. surgical; surgical vs. conservative, and conservative vs. conservative) and participant characteristics (gender, age >65 years, and age <65 years).

Missing Data: The primary analysis will adhere to the intention-to-treat principle, including all participants randomized to any intervention arm. For trials with missing outcome data, original researchers will be contacted to obtain necessary details, such as effect estimates, participant numbers, event counts, and measurement uncertainties. If data cannot be obtained, the impact of missing outcome data will be explored through sensitivity analyses (e.g., considering best-case and worst-case scenarios for missing data, or using specific imputation methods if feasible and justified) to assess the robustness of the treatment effects.

Confidence in cumulative evidence: The quality of evidence for each outcome will be assessed using Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach (28). The quality of the studies outcomes will be classified into four categories: high, moderate, low or very low. The authors will use the methods and recommendations of the Cochrane Handbook for Systematic Reviews of Interventions(24), and the GRADE Pro software will be utilized to generate 'Summary of findings' tables.

Ethics and dissemination: Ethical approval and patient informed consent are not required for this systematic review, as it will rely exclusively on data extracted from publicly available, published literature. The findings of this systematic review will be disseminated through publication in a peer-reviewed scientific journal and presented at relevant national and international scientific conferences.

Author Contributions:

- **Daniel Andrade:** Led the development of the research protocol, designed the study, and drafted the manuscript.

- **Marcel Jun Tamaoki:** Contributed to methodological design and conceptualization, provided ongoing project advisory, and ensured compliance with systematic review standards as the review guarantor.
- **João Carlos Belloti:** Assisted in refining the study design and contributed to the methodological framework.
- **Jorge Sayum:** Contributed to the development of the methodology and assisted in the literature review process.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflicts of interests: All authors have completed the ICMJE uniform disclosure form (available at <http://www.icmje.org/disclosure-of-interest/>) and declare: no support from any organization for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Data Sharing Statement: The extracted dataset supporting the findings of this systematic review will be deposited in the Dryad repository (<https://datadryad.org>). This deposit will occur on an ongoing basis as data are collected and analyzed, ensuring early accessibility rather than a single deposit at the conclusion of the study. The complete dataset will be publicly accessible and assigned a Digital Object Identifier (DOI). Specific details regarding the final availability and access conditions of the dataset will be periodically updated and reflected in the final published article.

Patient and Public Involvement Statement: No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for the design or implementation of the study. No patients were asked to advise on the interpretation or writing up of results. However, recognizing the importance of involving patients in the dissemination and communication of our research findings, we plan to create patient-friendly summaries and distribute them through community health talks and social media platforms.

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Supplementary Files

Multimedia Appendixes

Search Strategies.

URL: <http://asset.jmir.pub/assets/526fb69fe37846167d3c6af4a1ca8725.docx>

CONSORT (or other) checklists

Prisma-p checklist.

URL: <http://asset.jmir.pub/assets/a6eedba9305e3e7233c4ac086dc230fc.pdf>