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Review article

# Ankle arthrodesis—Open versus arthroscopic: A systematic review and meta-analysis

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ABSTRACT

*Objectives:* Our objective was to perform a systematic review of the literature and conduct a meta-analysis to investigate the outcomes of open versus arthroscopic methods of ankle fusion.
*Methods:* In accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement standards, we performed a systematic review. Electronic databases MEDLINE, EMBASE, CINAHL and the Cochrane Central Register of Controlled Trials (CENTRAL) were searched to identify randomised and non-randomised studies comparing outcomes of arthroscopic and open ankle arthrodesis. The Newcastle-Ottawa scale was used to assess the methodological quality and risk of bias of the selected studies. Fixed-effect or random-effects models were applied to calculate pooled outcome data.
*Results:* We identified one prospective cohort study and 5 retrospective cohort studies, enrolling a total of 286 patients with ankle arthritis. Our analysis showed that open ankle fusion was associated with a lower fusion rate (OR 0.26, 95% CI 0.13–0.52, P = 0.0002), longer tourniquet time (MD 16.49, 95% CI 9.46–23.41, P < 0.00001), and longer length of stay (MD 1.60,95% CI 1.10–2.10, P < 0.00001) compared to arthroscopic ankle fusion; however, there was no significant difference between two groups in terms of infection rate (OR 2.41, 95% CI 0.76–7.64, P = 0.14), overall complication rate (OR: 1.54, 95% CI 0.80–2.96, P = 0.20), and operation time (MD 4.09, 95% CI −2.49–10.66, P = 0.22). The between-study heterogeneity was high for tourniquet time but low or moderate for other outcomes. The direction of the effect sizes remains unchanged throughout sensitivity analyses.
*Conclusions:* The best available evidence demonstrates that arthroscopic ankle fusion may be associated with a higher fusion rate, shorter tourniquet time, and shorter length of stay compared to open ankle fusion. We found no significant difference between two groups in terms of infection rate, overall complication rate, and operation time. The best available evidence is not adequately robust to make definitive conclusions. Long-term results of the comparative efficacy of arthroscopic ankle fusion over open ankle fusion are not currently available. Further high quality randomised controlled trials that are adequately powered are required.



## 1. Introduction

The end-stage ankle arthritis is associated with substantial pain and severe limitation of function.[1–3] Ankle arthritis is twenty-five times less common than hip and knee arthritis, and >80% of ankle arthritis is posttraumatic. Conservative treatment options include anti-inflammatory medications, orthotic devices, and operative debridement. Once conservative treatment options fail, ankle arthrodesis has traditionally been the treatment of choice. Arthrodesis has been shown to have good clinical results in terms of pain relief. Ankle fusion can lead to a change in gait, with an effect on cadence and stride length, leading to abnormal motion of the subtalar joint; however, reduction in pain and return to activities still make the procedure a good choice for properly selected patients.[4]

After the first arthrodesis performed in early 19th century, technological advancement and better understanding of bone fusion has made possible for less invasive ankle fusion. Therefore, many different surgical procedures have been described of which open and arthroscopic fusion with internal fixation with screws have been widely practised. The results of previous studies suggest that arthroscopic fusion may be associated with decreased time to

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fusion, less complication in terms of infections, nerve injuries and decreased length of stay compared to open fusion.[5,6] Although the results of previous studies are promising, arthroscopic ankle arthrodesis was still relatively contraindicated for patients with substantial varus or valgus deformities of more than 10° during the late 2000s. Moreover, the use of the technique was limited to surgeons with a particular skill set in small joint arthroscopy, making open fusion more appealing for most orthopaedists.

Despite ongoing research, the most effective technique for ankle fusion is still controversial. The outcomes of arthroscopic and open ankle arthrodesis have been compared by some studies making a systematic review worthwhile. To our knowledge, there is no systematic review in literature comparing outcomes of open and arthroscopic methods of ankle fusion. Our objective was to perform a systematic review of the literature and conduct a meta-analysis to investigate the outcomes of open versus arthroscopic methods of ankle fusion. The robustness and quality of the available evidence was evaluated in a systematic and explicit approach with consideration of consistency and generalisability of the results.

## 2. Methods

This systematic review was performed according to an agreed predefined protocol. The review was conducted and presented according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement standards.[7,14]

### 2.1. Eligibility criteria

We planned to include all randomised controlled trials (RCTs) and observational studies comparing outcomes of arthroscopic and open ankle arthrodesis

### 2.2. Outcome measures

Fusion rate was considered as primary outcome measure. The secondary outcome measures included infection rate, overall complication rate, length of hospital stay, operative time, and tourniquet time.

### 2.3. Literature search strategy

Two authors independently searched the following electronic databases: MEDLINE, EMBASE, CINAHL and the Cochrane Central Register of Controlled Trials (CENTRAL). The last search was run on 01 December 2016. The details of the search strategy, which was adapted according to thesaurus headings, search operators and limits in each of the above databases, are appended in Appendix A. In addition, the following trial databases were searched for details of ongoing and unpublished studies: World Health Organization International Clinical Trials Registry http://apps.who.int/trial-search/, ClinicalTrials.gov http://clinicaltrials.gov/, ISRCTN Register http://www.isrctn.com/. We searched the bibliographic lists of relevant articles and reviews for further potentially eligible trials. No language restrictions were applied in our search strategies.

### 2.4. Study selection

Two authors independently assessed the title and abstract of articles identified from the literature searches. The full-texts of relevant reports were retrieved and those articles that met the eligibility criteria of our review were selected. We resolved any discrepancies in study selection by discussion between the authors. An independent third author was consulted in the event of disagreement.

### 2.5. Data collection

We created an electronic data extraction spreadsheet in line with the Cochrane's data collection form for intervention reviews. We pilot- tested the spreadsheet in randomly selected articles and adjusted it accordingly. Our data extraction spreadsheet included: study-related data (first author, year of publication, country of origin of the corresponding author, journal in which the study was published, study design, and study size); baseline demographic and clinical information of the study populations (age, gender, clinical presentation of the study participants, primary diagnosis of ankle pain, surgical procedure, and duration of follow up); and primary and secondary outcome measures data.

Two authors independently collected and recorded data and resolved disagreements by discussion. If no agreement could be reached, a third author was consulted.

### 2.6. Methodological quality and risk of bias assessment

The methodological quality and risk of bias of the included articles were assessed independently by two authors. We used the Newcastle–Ottawa scale (NOS)[8] for assessing the risk of bias of observational studies. The NOS uses a star system with a maximum of nine stars to evaluate a study in three domains (8 items): the selection of the study groups, the comparability of the groups, and the ascertainment of outcome of interest. For each item of the scale, we judged each study as low risk (one star awarded) or high risk (no star awarded). We determined studies that received a score of nine stars to be of low risk of bias, studies that scored seven or eight stars to be of moderate risk, and those that scored six or less to be of high risk of bias. Disagreements were resolved by discussion between the two reviewers. If no agreement could be reached, a third author acted as an adjudicator. A risk of bias graph was constructed to present the results.

### 2.7. Data synthesis and statistical analyses

For dichotomous outcome variables (overall complication rate, fusion rate, Infection rate), we calculated the odds ratio (OR). The OR is the odds of an event in the open fusion group compared to arthroscopic fusion group. For fusion rate, OR of more than one would favour open group and an OR of less than one would favour the arthroscopic group. For infection rate and overall complication rate, an OR of less than one would favour open group and an OR of more than one would favour the arthroscopic group. For continuous parameters (tourniquet time, operative time and length of stay) we used the mean difference (MD) between the two groups. We used the individual patient as the unit of analysis. Information about dropouts, withdrawals and other missing data were recorded and, if not reported, we contacted the study authors where possible. The final analysis was based on intention-to-treat data from the individual clinical studies.

The Review Manager 5.3 software was used for data synthesis. We used random effects or fixed effect modelling as appropriate, for analysis. We applied random effects models if considerable heterogeneity among the studies was identified. The results were reported in a forest plot with 95% confidence intervals (CIs). Heterogeneity among the studies was assessed using the Cochran Q test ($\chi 2$). We quantified inconsistency by calculating $I^2$ and interpreted it using the following guide: 0–25% may present low heterogeneity; 25–75% may represent moderate heterogeneity; and 75–100% may represent high heterogeneity. We planned to construct funnel plots and evaluate their symmetry to visually