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REVIEW ARTICLE

Operative versus nonoperative treatment of proximal humeral fractures: a systematic review, meta-analysis, and comparison of observational studies and randomized controlled trials

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Background: There is no consensus on the choice of treatment for displaced proximal humeral fractures in older patients (aged > 65 years). The aims of this systematic review and meta-analysis were (1) to compare operative with nonoperative management of displaced proximal humeral fractures and (2) to compare effect estimates obtained from randomized controlled trials (RCTs) and observational studies.

Methods: The databases of MEDLINE, Embase, CENTRAL (Cochrane Central Register of Controlled Trials), and CINAHL (Cumulative Index to Nursing and Allied Health Literature) were searched on September 5, 2017, for studies comparing operative versus nonoperative treatment of proximal humeral fractures; both RCTs and observational studies were included. The criteria of the Methodological Index for Non-Randomized Studies, a validated instrument for methodologic quality assessment, were used to assess study quality. The primary outcome measure was physical function as measured by the absolute Constant-Murley score after operative or nonoperative treatment. Secondary outcome measures were major reinterventions, nonunion, and avascular necrosis.

No institutional review board approval was necessary for this study.

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Results: We included 22 studies, comprising 7 RCTs and 15 observational studies, resulting in 1743 patients in total: 910 treated operatively and 833 nonoperatively. The average age was 68.3 years, and 75% of patients were women. There was no difference in functional outcome between operative and nonoperative treatment, with a mean difference of -0.87 (95% confidence interval, -5.13 to 3.38 ; $P = .69$; $I^2 = 69\%$). Major reinterventions occurred more often in the operative group. Pooled effects of RCTs were similar to pooled effects of observational studies for all outcome measures.

Conclusions: We recommend nonoperative treatment for the average elderly patient (aged > 65 years) with a displaced proximal humeral fracture. Pooled effects of observational studies were similar to those of RCTs, and including observational studies led to more generalizable conclusions.

Level of evidence: Level III; Systematic Review

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Keywords: Proximal humeral fracture; operative treatment; nonoperative treatment; observational studies; randomized controlled trials; elderly; current evidence

The proximal humeral fracture is the third most common fracture seen in elderly persons, with an incidence of 82 per 100,000 person-years, with an annual increase in the rate by 13.7% over the past 33 years.^{25,33,37} The typical patient is a woman aged 65 years or older.⁹ Nearly 75% of patients are treated nonoperatively, and 1 of 5 will undergo surgery depending on fracture type and displacement.²²

Depending on related factors such as patient age, activity, and fracture pattern, operative treatment options include minimally invasive reduction and intramedullary fixation, open reduction and internal plate fixation, or arthroplasty of the glenohumeral joint. Nonoperative treatment usually starts with immobilization followed by passive and active rehabilitation.²² Despite the fact that the available literature is inconclusive regarding the superiority of either treatment option, it is common practice to attempt joint-saving operative procedures in younger patients.^{16,22} In addition, there is no consensus on whether surgery is beneficial for the older patient with a displaced proximal humeral fracture.

Increasing scientific evidence has demonstrated that meta-analyses of both high-quality observational studies and randomized controlled trials (RCTs) can be similar in value to meta-analyses of RCTs alone in the field of orthopedic trauma surgery.^{1,2,19,41} Observational studies may give better insight into infrequent outcome measures, rare complications, and small effects of operative treatment while also increasing the generalizability of the results owing to an increase in patient numbers available for analysis or meta-analysis.

The aims of this systematic review and meta-analysis were (1) to compare operative versus nonoperative treatment of displaced proximal humeral fractures and (2) to compare effect estimates obtained from RCTs and observational studies. We hypothesized that (1) operative treatment of proximal humeral fractures does not improve functional outcomes as compared with nonoperative treatment and (2) including observational studies in this meta-analysis will lead to more robust conclusions without decreasing the quality of the results.

Methods

This systematic review and meta-analysis followed guidelines published by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and MOOSE (Meta-Analysis of Observational Studies in Epidemiology).^{26,43} These checklists aim to improve the reporting of systematic reviews and meta-analyses for RCTs and observational studies, respectively.

Search strategy and eligibility criteria

Two reviewers (R.B.B. and Y.O.) independently searched the MEDLINE, Embase, CENTRAL (Cochrane Central Register of Controlled Trials), and CINAHL (Cumulative Index to Nursing and Allied Health Literature) databases on September 5, 2017, for studies comparing operative and nonoperative treatment of proximal humeral fractures. The search syntax is provided in [Appendix S1](#). Both RCTs and observational studies were included. After screening of the titles and abstracts of identified records, studies were independently assessed based on full text. The eligibility criteria were proximal humeral fracture, operative versus nonoperative treatment, and reporting of functional outcomes, as well as complications. The exclusion criteria were language other than English, Dutch, or German; no availability of full text; inclusion of patients younger than 18 years; letters, meeting proceedings, and case reports; and external osteosynthesis as operative treatment. Disagreement over eligibility was resolved by discussion with a third reviewer (R.M.H.). The references of the included studies were screened for eligibility, and citation tracking was performed by using Web of Science to identify articles not found in the original search. Authors were approached via ResearchGate when no full-text version of the article was available.

Data extraction

Data extraction was done independently by 2 reviewers (R.B.B. and Y.O.) with a data extraction file. The following data were extracted: first author, journal, year of publication, study period, study design, country or countries in which the study was performed, fracture displacement, fracture classification system (Neer classification), follow-up, treatment groups, operative treatment, nonoperative treat-

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