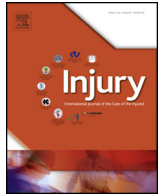




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Review

Union rate after operative treatment of humeral shaft nonunion – A systematic review

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ABSTRACT

Introduction: Humeral shaft nonunions can lead to morbidity from subsequent operations, complications and impaired function. Currently there is no evidenced-based consensus for treatment of humeral shaft nonunions.

Aim: We aimed to summarize and analyze union rates and complications after operative treatment for humeral shaft nonunion.

Methods: Studies investigating operative treatment strategies for humeral shaft nonunion were identified by searching: EMBASE, MEDLINE, Ovid SP, Web of Science, Cochrane Central, PubMed and Google Scholar up to October 24, 2014. Studies were eligible if: (1) outcome of operative treatment for humeral shaft nonunion was reported; (2) at least ten adult patients with humeral shaft nonunion included; (3) full text article available; (4) written in English, German or Dutch; and (5) nonunion was defined as no bone-bridging between the fracture ends after 6 months.

Results: Thirty-six studies were included. A union rate of 98% was found in patients ($n = 672$) who underwent plate fixation with autologous bone grafting (ABG), 95% in plate fixation without ABG ($n = 19$), 88% in intramedullary nailing with ABG ($n = 164$), 66% in intramedullary nailing without ABG ($n = 78$), 92% in bone strut fixation ($n = 91$) and 98% in external fixation ($n = 152$). A total complication rate of 12% was found in patients treated with plate fixation combined with ABG, 15% in intramedullary nail with ABG and 8% intramedullary nailing without ABG, 20% in bone strut fixation and 22% in external fixation.

Conclusion: Plate fixation with ABG was recommended for humeral shaft nonunion, since the union rate is highest and the complication rate is relatively low.

Level of evidence: Level IV.

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Introduction

Fractures of the humeral shaft account for 3–5% of all fractures [5]. The prevalence of humeral shaft nonunion after conservative and operative treatment for humeral shaft fracture ranges from 0.3 to 13% [15,16,30]. Nonunion of humeral shaft fractures often results in pain with prolonged disability resulting in reoperation, long absence from work, and impaired quality of life [11]. Many factors associated with compromised fracture healing have been described, including smoking, alcohol abuse, anti-inflammatory drug use, unstable fixation, poor patient compliance, devitalization of soft tissues, inadequate immobilization and infection [15,18,26].

Operative treatment to achieve adequate fixation in nonunited fractures is often complicated by coexistence of suboptimal surgical conditions including infection, prior surgical attempts or significant bone loss [6,23,25]. Varying treatment strategies for nonunion of humerus shaft fractures have been reported, ranging from (double) plating augmented with autologous bone graft, intramedullary fixation with bone morphogenetic proteins (BMP) to treatment with an external fixator. However, there is no evidence-based consensus regarding the optimal treatment of humeral shaft nonunions [17,19,21,23,37].

The primary aim was to compare union rates among operative treatment strategies for all forms of humeral shaft nonunion. Additionally we summarized complications per treatment modality.

Methods

Eligibility criteria

Studies were eligible if: (1) report on the outcome of operative treatment for humeral shaft nonunion was available; (2) at least ten adult patients with humeral shaft nonunion included; (3) full text article available; (4) written in English, German or Dutch; and (5) a nonunion was defined as no radiographic evidence of bony bridging between the fracture ends after 6 months. A study was excluded if the article was not an original study. Animal studies were also excluded.

Search strategy and information sources

Nonunion was defined as the nonappearance of bridging cortical bone across the fracture site on a radiograph as well as

presence of pain or motion at fracture site after 6 months of fracture treatment [35]. Studies that investigated operative treatment strategies for humeral shaft nonunion were identified by searching the following databases, up to 24 October 2014: EMBASE, MEDLINE Ovid SP, Web of Science, Cochrane Central, PubMed Publisher and Google Scholar (Appendix A). The EMBASE search strategy was transferred into similar search strategies in MEDLINE OvidSP, Web of Science, Cochrane Central, PubMed Publisher and Google Scholar. In addition, we manually searched all references of identified articles for potentially relevant articles.

Study selection

Eligibility assessment was performed by two independent reviewers (RP and FC). Disagreements were solved in consensus.

Data extraction

Data extraction was performed by the first author (RP) and checked and corrected by an independent second reviewer (FC). We extracted data including: author, year of publication, country of publication, study population (patient characteristics, population size, sex and age), design of study, fracture type, initial treatment, nonunion characteristics, operative treatment strategy, union rate, complications (infection, iatrogenic nerve injury, loss of fixation, re-fractures, or malalignment) and follow-up.

Methodological quality assessment

The methodological quality of the included studies was evaluated by two independent reviewers (RP and FC). Disagreements were solved in consensus. We used a standardized set of criteria based on modified questions of existing quality assessment tools [8,9,42] (Table 1). This rating system is binary: an article received 1 point when a criterion was met, otherwise 0 points were scored. Zero points were also given when information concerning a specific criterion was not mentioned in the article. To assess the methodological quality we used modified questions from existing quality assessment tools [8,9,42]. Articles could obtain a score ranging from 0 to 10 points. We considered articles of high methodological quality if a total score of 8 points or higher had been awarded, combined with an affirmative answer for questions 6–9.

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