Injury, Int. J. Care Injured 46S4 (2015) S58–S62

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Timing of surgery for open reduction and internal fixation of displaced proximal humeral fractures

Georg Siebenbürger, Dustin Van Delden, Tobias Helfen, Florian Haasters, Wolfgang Böcker, Ben Ockert*

Department of Trauma and Orthopedic Surgery, Munich University Hospital (LMU), Munich, Germany

KEYWORDS

proximal humerus fracture
locked plating
angular stable plating
timing of surgery
delay of intervention
osteosynthesis
complication
outcome

ABSTRACT

Background: Open reduction and internal fixation is one established method for treatment of displaced fractures of the proximal humerus. However, the timing of surgery and its effect on complications have not yet been investigated in the literature. Hence, aim of this study was to analyze the occurrence of complication following locked plating of proximal humeral fractures when surgery was delayed in comparison to early intervention.
Methods: Between February 2002 and November 2010, 497 patients with displaced proximal humeral fractures were treated by open reduction and locked plating. 329 patients were available for follow-up with a minimum of 12 months after surgery. Outcome analysis included radiographic evidence of loss of fixation (>10° of secondary displacement), screw-cutout and avascular head necrosis. Outcomes were analyzed with regards to age, gender and fracture pattern and were compared between time intervals in which the primary surgery had been conducted; early intervention (<48h), timely scheduled for surgery (3-5 days) and delayed intervention (>5 days).
Results: Of 329 patients (68.4% women; median age at time of surgery: 69.9 years, 95% Confidence Interval (CI) 68.2, 71.2) the median time between fracture incident and surgical intervention was 3.2 days (95%CI: 3.1, 3.3). Surgery was performed in a 2-part fracture at a median of 3.3 days (95%CI: 3.2, 3.4) after trauma, in a 3-part fracture after 3.3 days (95%CI: 3.1, 3.4), in a 4-part fracture 2.9 days (95%CI: 2.8, 3.0), in head split type fracture 2.2 days (95%CI: 2.0, 2.4) and in dislocation type fracture 0.8 days after trauma (95%CI: 0.7, 0.9, p = 0.40). Loss of fixation was observed in 12.8% (n = 42 patients), of which in 4.9% (n = 16) screw cutout was evident and in 6.8% of cases (n = 20) avascular head necrosis was diagnosed. Patients in which complication was observed were treated at median 2.5 days after trauma (95% CI, 1.8, 3.2), in comparison, patients without evidence of complications were treated at a median of 3.2 days (95% CI, 2.8-3.8, p = 0.35). The odds ratio regarding occurrence of complications for patients treated <48 hours was 0,924, for patients in which surgery was performed 3-5 days after the incident the odds ratio was 0,836 and in patients treated > 5 days the odds ratio was 1,637.
Conclusions: Loss of fixation following open reduction and internal fixation of proximal humeral fractures was not more frequently observed when surgery was performed 3-5 days after the incident in comparison to early intervention (<48h). However, a delay of intervention > 5 days is related to significant increase of complications. Thus, if open reduction and internal fixation is indicated, reconstruction of the proximal humerus should be performed within 5 days of the fracture event. In head split and dislocated fracture types anatomic reconstruction completed within 48h from the incident may be beneficial with regards to risk of avascular necrosis.

Introduction

Proximal humeral fractures represent about 5% of all fractures of the human body [1]. Due to a demographic change, the number of proximal humeral fractures is predicted to rise within the next years [2]. While non-displaced fractures may be treated non-operatively with good functional results, displaced and comminuted fractures indicate for surgery [3]. In the last decade open reduction and internal fixation by use of locking plates has become one established surgical treatment, however, complication rates following locked plating account for 20% including loss of fixation, screw cutout, and avascular necrosis of the humeral head [4-8].

Several studies aim to identify risk factors related to the occurrence of complications, including age, female gender and comorbidities. With regards to operative treatment of proximal humeral fractures an increase of complications is associated with delay of surgery, such as surgical-site infection, peripheral

* Corresponding author at: Department of Trauma and Orthopedic Surgery, Munich University Hospitals, Ludwig-Maximilians-Universität, Marchioninistr. 15, Munich 81377, Germany. Tel.: +49-89-4400-72429; fax.: +49-89-4400-54958.
E-mail address: Ben.Ockert@med.uni-muenchen.de (Ben Ockert).

thrombosis events and pneumonia [9]. However, besides patient immanent factors, fracture healing is also related to fracture morphology, disruption of the medial hinge and may depend on perfusion of the humeral head (i.e. intact blood supply) [10,11]. In terms of preservation of blood supply early reconstruction of the humeral head may be beneficial. However, to our knowledge, timing of surgery has not yet been analyzed for open reduction and internal fixation of displaced proximal humeral fractures in this context. As delayed surgical treatment could jeopardize vital bone structures, thereby negatively influencing the healing process, we hypothesize that an early intervention (<48 hours after trauma) may be advantageous in osteosynthesis.

The aim of the study therefore was to investigate the relationship between timing of surgery and complications associated to fracture healing following open reduction and internal fixation of proximal humeral fractures. In addition, we analyzed factors contributing to the time spent awaiting surgery.

Material and Methods

This study was conducted by approval of the local ethical review board (No.: 156-12). After giving their informed consent, patients were prospectively enrolled into the study and longitudinally followed up from the time of the operation, in consistency with the declaration of Helsinki. Medical records comprised demographic information, the effective date and time of the fracture incident, the fracture pattern as well as the documented date and time of the surgical procedure were included in a database.

Between February 2002 and November 2010, 497 patients with displaced proximal humeral fractures (Neer criteria) were included [12,13]. All fractures were treated by means of open reduction and internal fixation = ORIF. Exclusion criteria included open fractures, fractures resulting from primary or metastatic neoplasia, fractures with concomitant traumatic nerve deficiency. Patients were also excluded if locked plating was not the primary treatment (revision from other osteosynthesis). In addition, patients diagnosed with dementia or following apoplectic insults were also excluded from this study.

Surgical procedure

For ORIF surgical reconstruction of the humeral head was performed using locking plates (PHILOS®, Synthes DePuy GmbH, Oberdorf, Switzerland or NCB-PH®, Zimmer GmbH, Winterthur, Switzerland). Surgery was conducted by one of seven experienced trauma surgeons in upright beach chair position on a radiolucent table. Every patient received prophylactic intravenous antibiotics (Cefuroxime®) as a 1.5g single-shot and general anesthesia in combination with an interscalene block for postoperative pain control. Using a standardized deltopectoral approach, surgical reconstruction was achieved by restoring the humeral offset and anatomic reduction of fragments. Neither bone grafts nor bone cement or cement augmentation were used to support fixation in this study. The rotator cuff was evaluated for rotator cuff tears and tuberosity sutures (FiberWire No. 5®; Arthrex, Naples, FL, USA) were used predominantly. Screws were carefully driven into the subchondral layer, thereby not penetrating the articular surface of the humeral head. To ensure correct screw position and accurate fracture reduction, every step was verified by multi-plane fluoroscopy intraoperatively. When necessary, a screw was repositioned to obtain the intended distance and location of the screw tip relative to the subchondral bone and layer.

The post-surgical rehabilitation protocol allowed passive and active-assisted motion exercises, supervised by a physical therapist, beginning immediately on day one after surgery. Abduction and elevation was limited to 60°, without forced external rotation for the first 6 weeks, followed by active exercises with full range of motion and increasing strength exercises.

Follow-up and outcome measures

At every follow-up examination, patients were both interviewed according to a standardized protocol and physically examined by a member of the orthopedic surgery staff. The standardized follow-up comprised clinical and radiographic examinations of the affected shoulder at three, six and 12 months after surgery as well as at final follow-up. The median follow up was 4.5 years (95% Confidence Interval (CI) 4.2, 4.9) after surgery with a minimal follow-up of 12 months. From 497 patients a complete follow-up could be obtained of 329 patients (225 women ≙ 68.4% and 104 men ≙ 31.6%; median age: 64.9 years; 95%CI: 63.4 – 66.5, follow-up rate: 66.2%).

Radiographic evaluation

Every patient underwent true anteroposterior (a.p.) and outlet view radiographs of the injured shoulder. The fracture pattern was determined according to the Neer classification. In most cases additional CT-scan was obtained for a comprehensive identification of the exact fracture type. Our clinical follow-up comprised x-rays in true a.p. and outlet-view at 3, 6, and 12 months after surgery to verify the bone healing process and identify complications. At final follow-up, x-rays were only performed if the patient reported of pain, or if a decrease in range of motion or a low functional result was identified with respect to ethical committee objections.

Radiographs were evaluated for any complications related to the fracture fixation: loss of fixation, secondary displacement >10°, screw cutout, osteonecrosis of the humeral head, nonunion, malunion or failure of the implant (loosening, breakage).

Statistical analysis

We described continuous variables by median and 95% confidence intervals (95% CI). Timing of surgery for different fracture patterns was compared using Kruskal-Wallis-Test. To calculate the median time period, with or without occurrence of complications, the Mann-Whitney-U-Test was used. To compare the risk of complications for surgery at different time intervals after trauma the odds ratio was calculated. Level of significance for all testing was set at $p < 0.05$. Statistical analysis was performed with SPSS version 23 (SPSS Inc., Chicago, IL, USA).

Results

Of the 329 patients (225 women ≙ 68.4% and 104 men ≙ 31.6%; median age: 64.9; 95%CI: 63.4 – 66.5) the median time period (Δ) between trauma incident and the surgical procedure (open reduction and internal fixation by use of locking plates, ORIF) was 3.2 days (95% CI: 2.7 - 3.6).

In 151 cases (45.9%) the surgery was performed within 48h from trauma, in 135 cases (41.0) between 48h and 4 days, and in 43 cases (13.1%) 5 days or later, respectively. There were no differences in age and gender between the groups (p=0.913; p=0.862, Table 1).

The fracture patterns according to Neer classification were as following: 2-part fracture = 126 patients (38.3%), 3-part fracture = 136 patients (41.3%), 4-part fracture = 43 patients (13.1%), head split type fracture = 11 patients (3.3%) and dislocation type fracture = 13 patients (4.0%). Regarding the timing of surgery with respect to fracture pattern there was no significant difference between the fracture types according to the Neer classification, however, there was strong tendency for dislocation type fractures to be operated on earlier (p=0,059, Table 2).