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Original article

Clinically relevant heterotopic ossification after elbow fracture surgery: A risk factors study

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ABSTRACT

Background: Heterotopic ossification (HO) is a common complication of elbow fracture surgery that can significantly impair function and range of motion (ROM). Whereas numerous studies have assessed HO after hip trauma or replacement surgery, few data have been reported on the prevalence and risk factors of HO after elbow fractures.
Hypothesis: Our objective was to investigate the prevalence and risk factors of clinically relevant HO after elbow fracture surgery under the hypothesis that the ability to identify high-risk patients would improve treatment tailoring and assist in meeting patient expectations.
Materials and methods: We retrospectively included consecutive patients who had surgery for elbow injuries between January 2007 and December 2011. Patient demographics, operative details, and radiographs were reviewed.
Results: Of 124 elbows in 122 patients, 38 (30.6%) had HO and 26 (21%) clinically relevant HO. The prevalence of clinically relevant HO was highest in floating elbow injury, followed by combined olecranon and radial head fractures, types A and B distal humerus fractures, and terrible triad injury. By multiple logistic regression, factors that independently predicted clinically relevant HO were fracture-dislocation (OR, 4.87; 95%CI, 1.78–13.29; $P = 0.002$) and longer time to surgery ($P < 0.05$). Of the 26 patients with clinically relevant HO, 6 (23%) eventually required revision elbow surgery to improve ROM.
Discussion: HO of the elbow occurred in almost one-third of our patients with surgically treated elbow fractures. Fracture-dislocation of the elbow and longer time to surgery independently predicted HO responsible for ROM loss. Clinically relevant HO was associated with significant morbidity.
Level of evidence: Level IV, retrospective study.

1. Introduction

Elbow fractures are common injuries that account for 2% of all fractures and 30% of all upper limb fractures [1,2]. Heterotopic ossification (HO) is a well-documented complication of elbow fractures seen in 3% of patients [3] overall and up to 15–20% of patients with severe elbow trauma responsible for fracture-dislocation [4].

HO is the abnormal formation of mature lamellar bone at extra-skeletal sites [5]. Symptoms may include pain, stiffness, loss of joint range of motion (ROM), and functional impairments [6]. Whereas many studies have investigated HO after hip trauma or replacement surgery [7–12], few published data exist on the prevalence and risk factors of HO after elbow fractures. However, during the conduct of our study, three articles on risk factors for HO after elbow fractures were published [13–15].

Our objective was to investigate the prevalence and risk factors of HO in an unselected population with surgically treated elbow fractures. We compared our results to those of the earlier studies in order to test the robustness of our findings.

2. Material and methods

2.1. Patients

Consecutive patients admitted to our teaching hospital in Singapore for the surgical treatment of elbow fractures over the 5-year period from January 2007 to December 2011 were included retrospectively. Our institutional review board approved the study.

The patients were identified via a comprehensive search of the hospital electronic database for diagnostic and operative codes indicating surgically treated elbow fractures. Exclusion criteria

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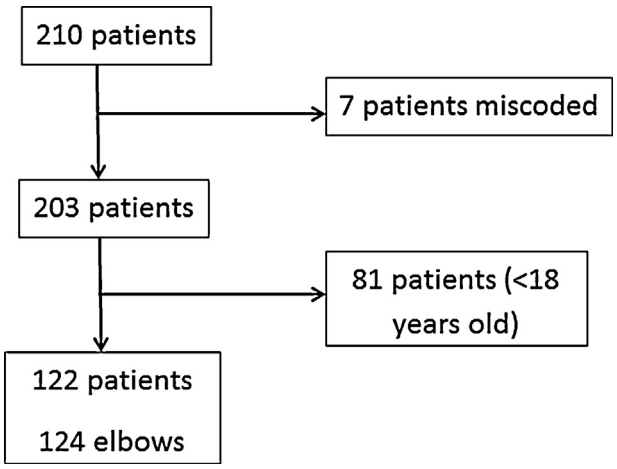

Fig. 1. Flowchart showing the patients included and excluded in the study.

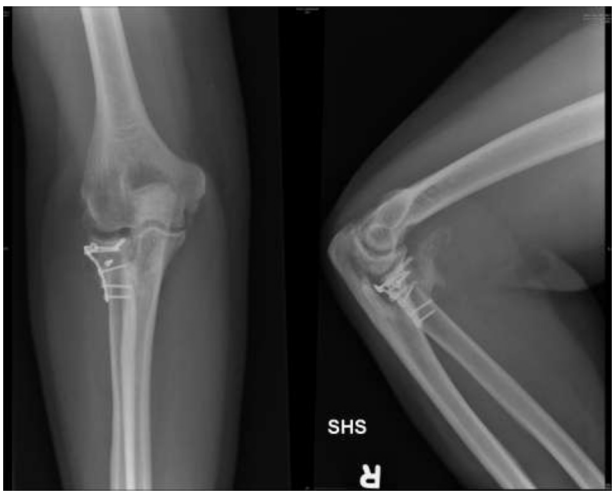

Fig. 2. Example of heterotopic ossification (HO) seen over the anterior aspect of the elbow after a radial head fracture.

were pathological elbow fracture, age younger than 18 years, and/or follow-up duration less than 6 months. Our decision to exclude patients younger than 18 years was based on the possibility that the propensity for developing HO may differ between skeletally immature and mature individuals. We identified 210 patients. A review of their electronic and handwritten records showed coding errors in 7 patients and age younger than 18 years in 81 patients. No patients had pathological fractures secondary to infection or malignancy. Thus, 122 patients were included, including 2 with bilateral elbow fractures, yielding 124 elbows for the statistical analysis (Fig. 1). Follow-up was 6 months or more in all patients.

2.2. Data collection

We recorded the following clinical parameters for each patient: age and gender; mechanism of injury; presence of polytrauma, concomitant burns, or head injury; presence of fracture-dislocation and/or compound fracture; time to surgery; and intraoperative findings. Radiological parameters included presence or absence of HO on radiographs, with the location and severity of HO. Recorded outcomes were bone union and complications. All data were tabulated and subjected to statistical analysis.

Mechanisms of injury were categorised as high-velocity, low-velocity, and other. High-velocity injuries were road traffic accidents and falls from above standing height. Low-velocity injuries were direct impacts and falls from no more than standing height. The other injury category included crush injuries and gunshot wounds. Distal humerus fractures were classified using the Arbeitsgemeinschaft für Osteosynthesefragen (AO) system [16] and other injuries using descriptive terms to reflect their variable nature. These choices facilitated comparisons with previous studies [13–15]. Diagnostic groups included isolated olecranon fractures, isolated radial head fractures, transolecranon fractures, floating elbow injuries, terrible triad injuries, Monteggia injuries, distal humerus fractures, and combined olecranon and radial head fractures. Floating elbow injuries were defined as concomitant fractures of the distal humerus and proximal radius and ulna, and terrible triad injuries as fractures of the radial head and coronoid process combined with posterolateral elbow dislocation.

HO was sought on anteroposterior and lateral elbow radiographs taken repeatedly during follow-up (Fig. 2). HO was categorised based on location relative to the elbow as anterior, posterior, collateral, anterior and posterior, anterior and lateral, posterior and lateral, and involving all three sites [17,18]. HO was also classified according to effects on elbow ROM, using the Hastings and Graham classification [18] (Box 1), in which Class 1 indicates no ROM limitation, Class 2, some ROM limitations, and Class 3, ankylosis. We defined clinically relevant HO as HO causing functional limitation, i.e., Class 2 or 3.

Box 1: Hastings and Graham classification.

Class I: radiographic heterotopic ossification without functional limitation.

Class II: radiographic heterotopic ossification with subtotal functional limitations.

IIA: limited flexion - extension.

IIB: limited pronation - supination.

IIC: limited in both planes.

Class III: radiographic and functional ankylosis.

IIIA: ankylosis in flexion - extension.

IIIB: ankylosis in pronation - supination.

IIIC: ankylosis in both planes.

Time to surgery was calculated from the time of emergency department triage to the time the surgical incision was performed. We categorised time to surgery as ≤ 24 hours, 2–7 days, and > 7 days. Postoperative radiographs were reviewed. Fracture union was defined as complete cortical bridging between the proximal and distal fragments with no visible fracture line. Computed tomography (CT) was not performed routinely. None of the patients received prophylactic or postoperative non-steroidal anti-inflammatory drugs (NSAIDs) or radiation therapy. All surgical procedures were performed by fellowship-trained orthopaedic consultants and specialist registrars.

2.3. Statistical analysis

Data entry was performed using a spreadsheet application (Excel 2003, Microsoft Corp., Redmond, WA, USA). Frequency tables and descriptive statistics are reported for all variables. Categorical variables are described as n (%) and continuous variables as mean ± SD or median, as appropriate. Bivariate logistic regression was used to assess associations between potential risk factors and HO development. Potential risk factors yielding P values < 0.05 by bivariate analysis were assessed in multiple logistic regression models to control for confounding factors. Values of $P \leq 0.05$ were considered significant. Data analysis was performed using SPSS (version 16, SPSS Inc., Chicago, IL, USA).