SCIENTIFIC ARTICLE

Risk Factors for Posttraumatic Heterotopic Ossification of the Elbow: Case-Control Study

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Purpose Heterotopic ossification (HO) is well-known after surgical repair of elbow fractures, but little is known about risk factors for its development in these patients. The purpose of this study was to define factors associated with development of HO.

Methods We used a prospective fracture registry collected in 2 Level I trauma centers and medical chart review to examine all elbow fractures treated surgically between 2002 and 2009. We determined which of these patients developed HO with an impact on range of motion (Hastings class II and III). We conducted a matched case-control study to examine factors associated with risk of HO. We used conditional logistic regression to compare occurrences of risk factors between cases and controls, matched by fracture type, age, and sex.

Results Our database contained 786 elbow fractures treated surgically. Of these, 55 developed clinically relevant HO. The risk of HO varied among types of elbow fractures, with combined olecranon and radial head fractures having no HO and floating elbows (fractures on both sides of the elbow joint) having the highest incidence of HO at 36%. In multiple conditional logistic regression, risk factors for the development of HO were days to surgery, with subjects waiting 8 or more days having 12 times the odds of HO than subjects having surgery within a day of injury, and time to postoperative mobilization, with subjects who had at least 15 days to mobilization having greater odds of HO than those who had less than 7 days to mobilization.

Conclusions Heterotopic ossification of the elbow occurs frequently after surgical repair of elbow fractures, with an incidence of 7% in this registry. In the case-control sample, conditions associated with development of HO included longer time to surgery and longer time to mobilization after surgery. *(J Hand Surg 2012;37A:1422–1429.*

Type of study/level of evidence Prognostic III.

Key words Elbow fracture, heterotopic ossification.

Additional material is available online.

HETEROTOPIC OSSIFICATION (HO) DESCRIBES the formation of mature lamellar bone in soft tissue structures.[1] Factors required for the development of HO include an initiating event (usually local soft tissue trauma, inflammation, or vasogenic edema), signaling from the injury site (likely bone morphogenetic analogs, receptors, and inhibitors), local immature mesenchymal cells with the ability to differentiate into osteoblasts, and a local environment conducive to cell maturation and bone production.[2–8] However, even in patients with all these factors, the incidence and severity of HO vary widely.

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The development of HO is a well-known complication following surgical repair of elbow fractures. The incidence of HO following elbow fracture has been reported[9,10] at rates varying from 2% to 56%. Several risk factors have been proposed for the development of HO about the elbow. They include genetic predisposition,[11,12] severity of trauma,[13] concomitant neurologic injury,[14,15] surgical approach, and hematoma formation.[16,17] Despite this, when faced with an elbow fracture, the surgeon has limited ability to predict which patients are likely to develop this complication.

We designed a retrospective case-control study of patients with surgically treated elbow fractures. We evaluated patients who developed HO after surgery, compared to controls who did not. The purpose of this study was to define factors associated with the development of HO.

MATERIALS AND METHODS

Study subjects

Our 2 institutions have collected information on all fractures of the upper extremities, lower extremities, and spine in a single combined prospective registry since 2002. Data regarding fracture type (AO classification[18]) and soft tissue status (Gustilo and Anderson classification[19]) are entered by orthopedic surgery residents at the time of the patient's initial presentation. Attending orthopedic surgeons then review the data and add information on surgical treatment and complications. In this registry, there were 786 fractures around the elbow that were treated with open surgery between 2002 and 2009. These fractures were treated by 47 different orthopedic surgeons, all of whom were either in fellowship or had completed fellowship training in hand and upper extremity, trauma, arthroplasty, or sports medicine. All secondary surgeries on patients with HO were performed by 6 surgeons, specialists who frequently care for patients with this condition. For this study, the injury radiographs of each elbow fracture were viewed to either confirm that the fracture type specified in the registry was correct or reclassify it if the fracture type specified was incorrect. Any unusual fractures or those that were challenging to classify were also reviewed by the senior author (G.S.M.D.).

We classified fractures according to the AO method.[18] This method worked to describe fractures of the distal humerus; however, for fractures of the proximal radius and ulna, we found the AO classification insufficient to describe the different classes of fractures we observed in the registry. We therefore grouped fractures of the proximal forearm based on descriptive terms. These groups were anterior Monteggia injuries, posterior Monteggia injuries, isolated olecranon fractures, isolated radial head fractures, transolecranon fracture-dislocations, terrible triad injuries (fracture of the radial head and fracture of the coronoid combined with an ulnohumeral dislocation), and floating elbow injuries (concomitant fractures of both the forearm and the distal humerus). Injuries that involved 2 components of a terrible triad injury (for example, a radial head fracture with an ulnohumeral dislocation) were maintained as separate categories during data collection and matching. We later grouped these fractures with terrible triad injuries for analysis.

TABLE 1. Hastings Classification of Heterotopic Ossification About the Elbow

Class	Description
I	Radiographic HO without functional limitation
IIA	Limitation in elbow flexion/extension plane
IIB	Limitation in forearm pronation/supination plane
IIC	Limitation in both planes of motion
III	Ankylosis of forearm, elbow, or both

Each of the 786 subject medical records was also reviewed to determine whether the patient went on to develop clinically relevant HO about the elbow. We defined *clinically relevant HO* as heterotopic bone visible on plain radiographs with corresponding functionally limiting loss of elbow motion. This corresponds to Hastings[20] class II and III HO (Table 1). In Hastings' original classification, the functional limitation of motion in patients with class II HO was not defined. To be consistent between subjects, we used Morrey and colleagues' definition[21] of functionally limited motion: an arc of elbow motion less than 30° to 130° or an arc of forearm motion less than 110°. These measurements were recorded from the last follow-up office note available for each subject and were assumed to be clinical estimates. Only study subjects who had both visible HO and functional limitation were included as cases of HO. Conversely, only subjects with no visible HO and no functional limitation of motion were eligible to be used as controls. Subjects with one or the other, but not both, were excluded from serving either as cases or as controls. We used this strict definition to avoid accidentally studying something else, like soft tissue contracture of the elbow, which is also common after injuries like the ones in our cohort.