Radial head fractures treated by open reduction and internal fixation with an extensor digitorum communis split approach

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Background
The treatment of displaced fractures of the radial head is controversial, with conflicting evidence to support either resection or open reduction and internal fixation. The aim of the present study was to evaluate the outcomes of primary open reduction and internal fixation of displaced radial head fractures using the extensor digitorum communis (EDC) split approach.

Patients and methods
Between June 2007 and September 2011, 19 consecutive patients with a displaced radial head fracture underwent open reduction and internal fixation. All fractures were classified as type III according to the Mason classification system. The EDC split approach was used. The Mayo Elbow Performance Score was used for clinical assessment.

Results
The Mayo Elbow Performance Score averaged 81.4 points postoperatively. According to this scoring system, the result was rated as excellent for 13 patients, good for three patients, and fair for three patients. There was a slight radiographic degenerative change only in two elbows.

Conclusion
Following a displaced radial head fracture, the overall results of radial head preservation by open reduction and internal fixation would be better in terms of satisfactory joint motion, with greater strength and better function. The EDC split approach provides good access to the displaced fragments.

Keywords:
Radial head fractures, open reduction, extensor digitorum communis split

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Introduction

Although radial head fractures represent a very common injury in everyday clinical practice, their proper management remains difficult and controversial. Radial head fractures are often misdiagnosed because symptoms are similar to elbow sprains; they usually result from a fall onto the outstretched hand. This type of fracture may be isolated or associated with more complex injuries such as fractures and dislocations around the elbow, soft-tissue injuries, and rupture of the distal radioulnar joint. Radial head fractures may be the result of indirect trauma and constitute approximately one-third of all fractures and elbow dislocations. Radial head fractures are involved in ~20% of elbow trauma cases [1,2] and 5–10% of elbow dislocations are associated with a radial head fracture [3,4]. The degree of ligamentous injury that occurs with a radial head fracture is not always fully appreciated. Previous investigators have reported various results with respect to the incidence of associated bony or ligamentous injuries [5]. The combination of a radial head fracture with attenuation or medial collateral ligament tear has been reported to occur in 1–2% of patients [6]. The treatment of displaced comminuted fractures of the radial head is controversial, with conflicting evidence to support either resection or open reduction and internal fixation [7,8]. Improper internal fixation interferes with the smooth congruity of the proximal radioulnar articulation, and this limits joint motion, causing pain, and may lead to post-traumatic osteoarthrosis of adjacent joints. Therefore, radial head resection has been a valid therapeutic option, with reports of good long-term functional outcomes [9]. However, delayed complications, including pain, joint instability, proximal radial translation, decreased strength, osteoarthrosis, and cubitus valgus, have also been reported after radial head resection [10,11]. Radial head resection in patients with a severely comminuted radial head fracture, which is often associated with ligament disruption, may produce an extremely unstable elbow. The Kocher interval, between the extensor carpi ulnaris and anconeus, is commonly used for posterolateral exposure of the elbow. The traditional Kocher approach, which was first introduced in the early 1900s, was described as a posterolateral approach [12]. The capsulotomy in this approach was performed in line with the anconeus posterior to the central portion of the lateral ulnar collateral ligament. In the classic description of the posterolateral extended approach, the lateral collateral ligament is released upon incising the anterior capsule [13]. Because of improved understanding of the importance of the lateral ulnar collateral ligament

in preventing posterolateral rotatory instability, this approach is no longer advocated for radial head fractures and has since been modified. A more anterior capsulotomy through anterior mobilization of the extensor carpi ulnaris was introduced to preserve the stability of the posterolateral ligamentous complex [14]. This modified Kocher approach is now used widely in the fixation of radial head fractures. However, this approach can limit access to the anterior portion of the radial head, resulting in suboptimal visualization and difficulty in placing screws. The extensor digitorum communis (EDC) splitting approach is more anterior and may allow easier access to the more commonly fractured anterior aspect of the radial head, facilitating fracture fixation. The aim of the present study was to evaluate the results of open reduction and internal fixation of radial head fractures using the EDC split approach, which provides good access to the radial head fragments.

Patients and methods

Between June 2007 and September 2011, 19 consecutive patients with a comminuted and displaced radial head fracture underwent open reduction and internal fixation. All fractures were classified as type III according to the Mason [15] classification system. The average age of the patients at the time of the operation was 26.5 years. There were 15 men and four women. Fifteen fractures involved the right elbow and four fractures involved the left elbow. The dominant upper extremity was involved in 17 patients. Nine fractures were the result of a motor-vehicle accident; seven fractures were the result of a high-energy fall from a height; and three fractures were the result of a moderate-energy fall in the street or at home. All patients had an articular fracture of the entire head (Fig. 1). The average time from the injury to the operation was 5 days. The wound extended from the lateral humeral epicondyle toward the head of the radius about 6 cm. After dissecting the skin and subcutaneous tissue, the EDC muscle was identified and was bisected starting at its origin on the lateral epicondyle and extending to a point 25 mm distal to the radiocapitellar joint (Fig. 2). After the muscle splitting, the capsule and annular ligament were incised anterior to the equator of the capitellum to avoid injury to the lateral ulnar collateral ligament. All fractures of the radial head were internally fixed using low-profile mini-plates and mini-screws. The fracture was reduced and was held with small forceps clamps or it was temporarily fixed with 1.0 mm Kirschner wires. The low-profile mini-plate with a 1.7 mm screw diameter was used for fracture fixation (Fig. 3). Mini-screws were used to fix considerable fragments. Screw heads were countersunk and care was taken that the screw tips did not protrude out from the articulating portion of the radial head. Impacted fractures of the head often require elevation to restore the articular surface. In five patients, cancellous bone graft, obtained from the iliac crest, was placed between the radial head and neck. The annular ligament was sutured with number-1 nonabsorbable sutures. Forearm rotation exercises, with the extremity in a long-arm cylinder cast and the elbow at a right angle, were started 2 days after the surgery. The cast was worn for 3 weeks, after which active elbow movement was started.

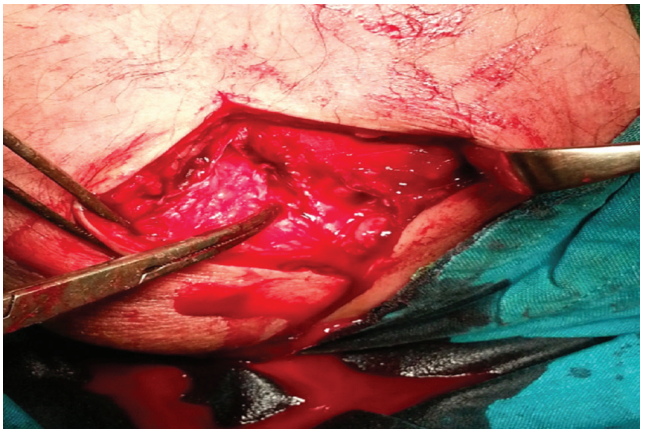
Postoperative assessment

The duration of follow-up ranged from 8 months to 2 years. Anteroposterior and lateral radiographs were prepared to determine the position of the radial head and the presence of any osteoarthritic changes or deformity.

Figure 1

Preoperative radiograph showing a comminuted fracture of the radial head.

Figure 2



The extensor digitorum communis muscle was identified and bisected.

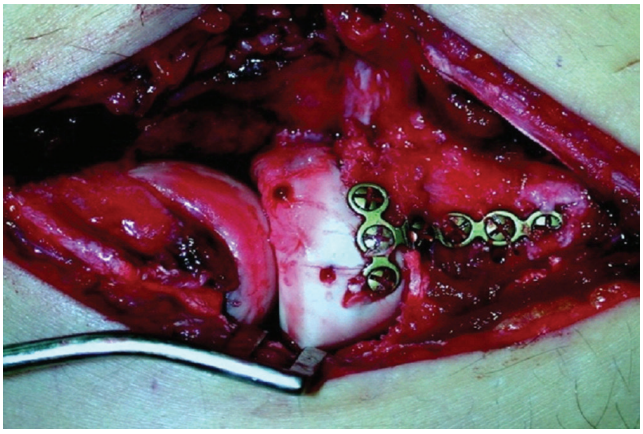
Evaluation

The elbows were evaluated using the Mayo Elbow Performance Score [11]. With this system, pain is rated as none, mild, moderate, or severe, with a maximum score of 45 points. Range of motion was measured using a handheld goniometer, with pronation and supination measured with the elbow at 90°; the maximum score for flexion is 20 points. Instability was recorded as none, moderate, or severe. Moderate instability is defined as more than 5° but less than 20° of varus–valgus excursion. The maximum score for stability was 10 points. The patient's ability to perform five specific activities of daily living and personal care, including combing the hair, feeding oneself, hygiene, buttoning a shirt, and tying shoelaces, was also assessed using the Mayo Elbow Performance Score. A maximum score of 5 points was assigned for each activity, with a total maximum score of 25 points. The overall performance index was calculated by adding all of the scores together. A score of 90 points or more indicated an excellent result; a score of 75–89 points indicated a good result; a score of 60–74 points indicated a fair result; and a score of less than 60 points indicated a poor result. An excellent or good result was considered satisfactory. The difference between the injured and uninjured elbows with respect to the strength of elbow flexion and extension was estimated by a subjective comparison between the elbows.

Statistical analysis

The Wilcoxon rank-sum test was used to compare the preoperative and latest values for flexion and extension, pronation and supination, and the Mayo Elbow Performance Score. A significant difference was defined as an observation that had less than a 5% probability of occurring by chance.

Figure 3



Intraoperative picture showing good reduction and fixation of the fracture.

Results

All fractures showed osseous union (Fig. 4). One patient with an open fracture had a delayed union, and it took 11 months until osseous union was evident radiographically.

Pain

The average pain score was 20.2 points. Four patients had mild pain in the elbow with strenuous use that required forearm rotation. Two patients complained of a dull ache and numbness along the ulnar aspect of the forearm.

Motion

At the time of follow-up, range of motion measurements showed a significant mean loss of 10° of extension of the treated elbow compared with the contralateral, normal elbow (P<0.05) Flexion averaged 127°, with 15 elbows having greater than or equal to 130° of flexion and four elbows having greater than or equal to 120°. The total flexion extension arc averaged 120°. No significant difference in elbow flexion or forearm rotation was observed between the affected and the unaffected limbs (Fig. 5).

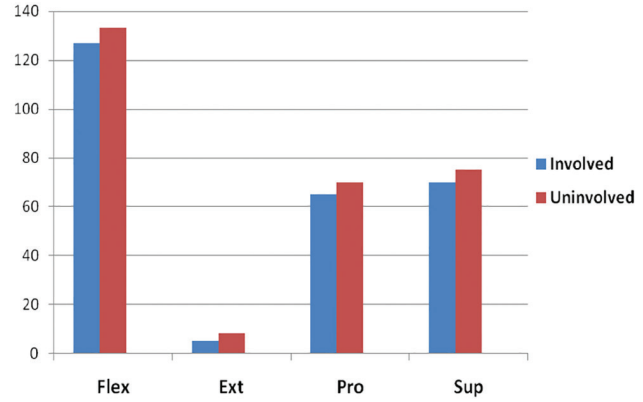
Functional instability

There was no evidence of anteroposterior elbow instability on manual testing. Manual stressing of the elbow in the varus–valgus plane, including provocative maneuvers for valgus and posterolateral instability, did not show any laxity in any patient. All patients had stable elbows postoperatively as the head radius was preserved. Analysis of the maximum varus–valgus laxity data indicated that there was no difference in stability between the injured elbow and the contralateral normal side. The rotational stability of the injured elbow was

Figure 4

Postoperative radiograph showing healing of the fracture.

Figure 5



No significant difference between involved and uninvolved elbows. Ext, extension; Flex, flexion; Pro, pronation; Sup, supination.

not significantly different from that of the contralateral sound side.

Functional assessment

The Mayo Elbow Performance Score averaged 81.4 points postoperatively. According to this scoring system, the result was rated as excellent for 13 patients, good for three patients, and fair for three patients. The radiographs prepared at follow-up showed slight degenerative changes in two elbows: one had a good reduction of the fracture fragments and the other had slight malalignment. Radial head excision was performed in one patient, mainly because of the persistence of elbow pain. Degenerative changes in the elbow were defined as subchondral cysts, subchondral sclerosis, and/or osteophytes formation.

Complications

One patient required antibiotics for a superficial wound infection in the immediate postoperative period. There were no deep infections. Occasional pain and/or paresthesias were present in two patients; however, these symptoms decreased with time, and, at the time of the final follow-up, they did not require treatment for this problem.

Discussion

Although radial head fractures are considered a relatively benign injury, their treatment is of great importance and has developed over the years using various techniques and methods [16]. The principal goal of treatment is to maintain good elbow function and thus to retain adequate motion and joint stability. In general, the treatment of radial head fractures is based on the fracture type and the presence of any associated injury. Acceptable long-term functional outcomes have been reported after primary or delayed radial head resection performed as a salvage operation for Mason type III fractures. Radial head resection has been associated with long-term complications, including wrist and forearm pain, increased valgus elbow deformity, degenerative osteoarthrosis, and decreased strength [17]. Currently, internal fixation is popular as contemporary techniques have improved surgical outcomes [18]. AO mini-screws and mini-plates, Herbert screws, and absorbable polyglycolide pins are used for the restoration of the fractured radial head and neck. An insertion of one or two 2.0 or 2.7 mm AO cortical mini-screws parallel to the radiohumeral joint can easily fix isolated large fragments. The defect beneath the elevated fragment is best filled with a cancellous bone graft [19]. Achievement of an accurate reduction, stable fixation, and minimization of soft-tissue damage are required for successful surgical management of a radial head fracture. In this study, the EDC split approach was used. The results of the present study show that the EDC splitting approach provided the greatest exposure of the anterior aspect of the radial head. Failure to adequately expos the anteromedial quadrant through the modified Kocher approach may result in the inability to appropriately judge fracture reduction, necessitating proximal extension of the approach. The additional proximal soft-tissue dissection and detachment of the origins of the forearm muscles could lead to prolonged recovery times, elbow contractures, and potential instability. When using the EDC splitting approach, the capsulotomy is collinear with the muscle split. In contrast, when using the modified Kocher approach, distal extension of the Kocher interval (and thus greater dissection) is required to enable sufficient anterior mobilization of the extensor carpi ulnaris. Anterior elevation and retraction of the extensor carpi ulnaris muscle is necessary to incise the joint capsule anterior to the lateral ulnar collateral ligament, but this is difficult because of the close apposition of the extensor carpi ulnaris fascia with the capsuloligamentous complex. The extended EDC splitting approach is believed to be less invasive than the extended modified Kocher approach as the extensor carpi ulnaris origin and the posterior half of the EDC origin are spared. Furthermore, a distinct band of the extensor carpi ulnaris located between the lateral humeral epicondyle and the proximal aspect of the ulna is believed to act as a secondary elbow stabilizer, and this band is at risk during the modified Kocher approach.

In the present study, 16 patients reported excellent and good results after open reduction and internal fixation of a radial head fracture. All of the patients

had Mason type III fractures. In a study of radial head fractures treated with reduction and internal fixation, Esser *et al.* [20] reported a good or an excellent outcome in all individuals with a Mason type II or III fracture, whereas two of six patients with a Mason type IV fracture had an inferior outcome. Poulsen and Tophöj [21] classified two of 33 outcomes of treatment with preservation of the radial head as poor, with a poor result defined as reduced working ability and/or limitation of motion exceeding 10° in one or more directions. In the present study, three of 19 patients with a Mason type III fracture were considered to have a fair result. One patient was later treated with a delayed excision of the radial head because of residual pain. Thus, the data indicate that the radial head can be saved initially and, if severe pain persists, a delayed radial head excision can be performed with the expectation of good pain relief. A reduced range of motion is a common symptom after elbow trauma, and several authors have contended that symptoms often occur with an elbow extension deficit exceeding 30° and/or elbow flexion of less than 130°. Other authors have suggested that symptoms are found if the extension deficit exceeds 20°; formerly injured upper limbs were found to have insignificantly less elbow flexion and extension and forearm supination than the uninjured upper limb. It is apparent that the statistically significant difference in the range of motion is the same as a clinically relevant difference as most former patients rated the elbow as having no or only minor symptoms [22]. The present study supports the findings of Caputo *et al.* [23], who noted that, although radiographic changes may develop after the majority of fractures of the radial head or neck, when they are treated initially without a radial head excision, there seems to be no increased risk of joint space reduction. There was a correlation between the radiological preservation of the radiohumeral joint and the prevalence of pain or loss of motion, which occurred in a minority of patients. Although the results of radial head excision following a fracture are not always good, as the treatment may lead to radial shortening at the wrist, there is evidence that the overall results of radial head preservation by open reduction and internal fixation would be better in the treatment of radial head fractures.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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