Mason type IV fractures of the elbow
A 14- TO 46-YEAR FOLLOW-UP STUDY

P. Herbertsson, R. Hasserius, P. O. Josefsson, J. Besjakov, F. Nyquist, A. Nordqvist, M. K. Karlsson

From Malmö University Hospital, Lund University, Malmö, Sweden

A total of 14 women and seven men with a mean age of 43 years (18 to 68) who sustained a Mason type IV fracture of the elbow, without an additional type II or III coronoid fracture, were evaluated after a mean of 21 years (14 to 46). Primary treatment included closed elbow reduction followed by immobilisation in a plaster in all cases, with an additional excision of the radial head in 11, partial resection in two and suturing of the annular ligament in two. Delayed radial head excision was performed in two patients and an ulnar nerve transposition in one. The uninjured elbows served as controls. Nine patients had no symptoms, 11 reported slight impairment, and one severe impairment of the elbow. Elbow flexion was impaired by a mean of 3° (SD 4) and extension by a mean of 9° (SD 4) (p < 0.01). None experienced chronic elbow instability or recurrent dislocation. There were more degenerative changes in the formerly injured elbows, but none had developed a reduction in joint space.

We conclude that most patients with a Mason type IV fracture of the elbow report a good long-term outcome.
scrutinised the in- and outpatient registers and the operation registers of the Department of Orthopaedics for patients treated for a Mason type IV fracture of the radial head or neck between 1957 and 1968, and between 1980 and 1989. This search identified another 42 individuals with this fracture type, of whom 21 were still living in the region at the time of follow-up. A total of 13 of these agreed to participate making a total of 24. However, after examination three of the individuals with a former Mason type IV fracture were excluded, after examination, because they were found to have associated fractures in the same extremity, one in the distal radius, one in the capitellum and one in the olecranon. Of the 21 patients, 14 had a concomitant ligament injury at the initial injury. A total of 14 patients had a small avulsion of the coronoid process (Regan and Morrey type I injury), one had a minimal avulsion fragment of the lateral humeral condyle as a sign of a lateral ligament injury, and another had an avulsion fragment of the medial humeral condyle representing a medial ligament injury. Among the 21 patients with a dislocation of the elbow and an associated fracture of the radial head, the radial head injury was a Mason type I fracture in five individuals, a type II fracture in two and a type III fracture in 14.

There were 14 women and seven men, with a mean age of 43 years (18 to 68) at injury in the study group and the follow-up examination was conducted a mean of 21 years (14 to 46) after the injury. In nine patients the left elbow was affected and in 12 the right elbow. None had other major fractures or soft-tissue injuries to the upper extremities.

The type of injury and the primary and secondary treatments were retrospectively determined through the hospital records. A total of 16 patients had experienced low-energy trauma, defined as a fall in the same plane or a fall from less than 2 m, or sustaining a kick or a blow, whereas five patients had suffered a high-energy trauma, defined as a fall from a height of more than 2 m or being involved in a motor-vehicle accident or a similar level of trauma. Primary treatment included closed reduction of the elbow dislocation and excision of the radial head in 11 patients, closed reduction of the dislocation and partial resection of the radial head in two, closed reduction of the dislocation and ligament suture in two, and closed reduction of the dislocation in six. All the patients were also treated with immobilisation in a plaster cast for a median of three weeks (2 to 6). The on-call surgeon decided on the treatment and we could not identify the specific reason for choosing a radial head excision as the primary form of treatment in any patient record. No intra- or post-operative complications were recorded. A delayed radial head excision was performed after one month in one patient and after three months in another because of residual pain. An ulnar nerve transposition was undertaken 18 months in one patient because of nerve compression symptoms.

The subjective outcome was recorded in all patients at follow-up by a questionnaire evaluating activities of daily living, elbow pain on loading and at rest, tenderness, loss of strength and range of movement in the previously fractured elbow. Pain in the ipsilateral wrist and hand were also evaluated.

Clinical examination was also performed in the 19 former patients who had accepted a radiological examination. Flexion and extension of the elbow and the wrist, pronation and supination of the forearm, and the angle of the extended elbow were measured with a goniometer. Grip strength of the hand was evaluated by a Martin vigorimeter (Heinrich C. Ulrich, Werkstätten für Medizinmechanik, Ulm-Donau, Germany) and the circumference of the arm and forearm respectively 10 cm above and below the tip of the olecranon was measured using a tape measure. The uninjured arm served as the control. The difference between the two sides in the strength of elbow flexion and extension was estimated by a subjective comparison between the elbows. Tinel’s test in sulcus nervi ulnaris (cubital tunnel) was performed on both the elbows.

Lateral radiograph of the elbow showing a) a Mason type IV fracture initially treated by radial head excision, and b) at follow-up 21 years after the fracture.
The radiological evaluation at the time of injury included a plain anteroposterior (AP) and lateral radiograph of both the elbows. The fractures were classified according to the Mason classification\(^1\) modified by Broberg and Morrey\(^2\) by a radiologist (JB) with no knowledge of the treatment, subjective evaluation or clinical outcome. Follow-up radiographs were obtained in 19 patients and included an AP and lateral view of both elbows, and AP of the wrists. As the research protocol was unclear initially, the first five individuals who came for a follow-up examination had radiographs of their elbows only, and the wrist radiographs were obtained only for the 14 other patients. Degenerative changes were defined as subchondral cysts, sclerosis and/or osteophytes, and the number of patients with reduction of the joint space by more than 1 mm in comparison with the uninjured elbow was recorded.\(^3\) In the elbows where a radial head excision had been performed, joint space height was evaluated only in the medial compartment. Miscellaneous pathology, such as nonunion, avascular necrosis of the radial head, proximal radio-ulnar synostosis and periarticular ossification, were also evaluated. The prevalence of the length of the ulna exceeding that of the radius at the wrist by 2 mm or more when compared with the contralateral wrist was also recorded.

The study was approved by the Ethical Committee of Lund University and carried out according to the Declaration of Helsinki.\(^4\) Data are presented as median and range or mean and SD. Comparison between the two arms of the same individual was made by Student’s \(t\)-test between pairs and the chi-squared or Fisher’s exact test. A \(p\)-value of < 0.05 was regarded as statistically significant.

**Results**

Of all the patients with a radial head or neck fracture during the period 1969 to 1979, only 2\% had a Mason type IV fracture. This implied an annual incidence of Mason type IV fractures of 0.06 per 10 000 individuals (0.006\%) during this period. Furthermore, we found no patient below the age of 18 at the time of sustaining this fracture.

Subjectively, at follow-up nine of the 21 patients had no complaints in the formerly fractured elbow, 11 had slightly impaired elbow function, and one had severely impaired elbow function (Table I). The one with severe impairment was a woman who had suffered high-energy trauma and had been treated with closed reduction of the elbow dislocation followed by removal of the radial head. Four patients reported subjective reduction in grip strength in the formerly fractured arm. None had experienced recurrent dislocation of the elbow (Table I). Among the patients treated with excision of the radial head, four reported no elbow symptoms, whereas 11 reported a subjective impairment in the elbow. Of the two patients treated with a partial resection of the radial head, both reported an impairment in the elbow. Among the eight patients with non-operative treatment, five reported no elbow problems, whereas three reported elbow impairment. Among the five patients with a Mason type I fracture of the radial head, three reported no symptoms but two reported subjective elbow impairment. One of the two patients with a Mason type II fracture reported no symptoms, and one reported some impairment. Finally, among the 14 patients with a Mason type III fracture, five reported no subjective elbow symptoms, whereas nine reported some impairment.

Objectively, the mean flexion of the elbow was impaired compared to the contralateral elbow (140\° (SD 8) versus 142\° (SD 7), \(p < 0.01\)) as was the mean extension (-10\° (SD 13) versus -1 (SD 2), \(p < 0.01\)) (Table II). Three individuals had an impaired extension of 20\° or more (Table I). None had flexion of less than 130\° in the formerly injured elbow. One patient had a positive Tinel’s sign in the injured arm (\(p = 1.0\)). There was no objective reduction in grip strength or impaired range of movement in the wrists in the formerly fractured arm.

Radiologically, the formerly injured elbows had more degenerative changes than the uninjured elbows, cysts in ten versus one, irregular subchondral bone in 14 versus one, and osteophytes in 11 versus two, \(p < 0.01\) for all (Fig. 1). No formerly fractured elbows had a reduced joint space compared to the uninjured elbows. There were no nonunions, avascular necroses, proximal radio-ulnar synostoses and/or periarticular ossifications. Apparent lengthening of the ulna of 2 mm or more was found in five formerly injured arms. None of these patients reported weakness of the wrist. The mean grip strength in the individuals with an ulna plus of more than 2 mm in the formerly injured arm was 0.75 kg/cm\(^2\) (SD 0.23), compared to 0.80 kpm/cm\(^2\) (SD 0.21) in the uninjured arm (\(p = 0.19\)).

**Discussion**

This study supports the contention that Mason type IV fractures of the elbow are rare, practically not occurring in children, leaving no or only minor long-term symptoms in half of the cases up to 46 years after the trauma. However, it seems probable that we underestimated the actual number of such fractures. A Mason type IV fracture where the elbow dislocation was restored prior to the radiographs being obtained (and hence not captured on the radiographs) would, according to our classification system, not be a Mason type IV fracture. Only three of 21 patients had severe symptoms, and none had developed a radiological reduction in the joint space in the elbows. However, it is important to emphasise that patients with significant concomitant coronoid fractures, such as those seen in the terrible triad injuries (elbow dislocation, fracture of the radial head and fracture of the coronoid process), were excluded from this cohort and that the results in this report could not be generalised to patients with a significant coronoid fracture.

Mason\(^3\) described a classification of radial head fractures including three different types of fracture. Dislocation of the elbow associated with a radial head fracture was first described as a Mason type IV by Johnston,\(^7\) and radial
Table I. Case-specific information for the 21 individuals with a Mason type IV fracture

<table>
<thead>
<tr>
<th>Case</th>
<th>Age at injury (yrs)</th>
<th>Follow-up (yrs)</th>
<th>Trauma type</th>
<th>Injured side</th>
<th>Mason type of fracture</th>
<th>Primary treatment</th>
<th>Plaster (wks)</th>
<th>Delayed treatment</th>
<th>Subjective at follow-up</th>
<th>Objective at follow-up</th>
<th>Flexion deficit</th>
<th>Extension deficit</th>
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Neck fractures were later included by Broberg and Morrey\(^2\) in their modified Mason classification. Mason type IV fractures are generally regarded as uncommon\(^11\) and only a few studies in the literature have followed those fractures over the longer term. Furthermore, most studies have been short-term follow-ups of a few individuals, including those with additional fractures of the elbow.\(^17,19,21,26,38-40\) Broberg and Morrey\(^2\) followed 24 patients with a Mason type IV fracture for a mean of ten years, but they also included additional fractures of the coronoid process, the lateral epicondyle, the olecranon and the capitellum. The outcome in the 14 patients with a Mason type IV fracture without additional fractures was reported as excellent in two, good in seven (even if one had a re-dislocation two months after the injury) and fair in five. All the patients were treated by reduction of the dislocation and immobilisation in plaster, in two patients with an additional partial radial head resection, in two with a total radial head excision and in one with a radial head prosthesis. Esser, Davis and Taavao\(^41\) reported a good or excellent outcome in four of six patients with a Mason type IV fracture treated with reduction and internal fixation. However, in three patients there was also a fracture of the coronoid process, in two a fracture of the capitellum, and in one a fracture of the prox-
A fragment of the coronoid process did not have recurrent Mason type IV fracture with or without a small avulsion elbow dislocations. Similar conclusions have been made by other authors but opposed by others. A common recommendation in the literature is that excision of the radial head should be performed two to three weeks after the injury to reduce the risk of instability. However, a randomised study with up to 46 years’ follow-up is unlikely to ever succeed. Furthermore, because of the sample size, this study cannot verify or reject the hypothesis that individuals whose radial head was preserved had a more favourable outcome than those whose radial head was excised. Also, the risk of developing relative lengthening of the ulna, commonly referred to as an ulna plus arm with wrist problems in the formerly injured arm seemed to be low after a Mason type IV fracture, even in patients in whom a radial excision had been performed. The main strength of this study is that it is the first published study to include only patients with an isolated Mason type IV fracture and it includes the largest sample of patients with this injury with the longest follow-up presented, including a radiological follow-up of both elbows and wrists. The weakness is that no randomised treatment was advocated. However, a randomised study with up to 46 years’ follow-up is unlikely to ever succeed. Furthermore, because of the sample size, this study cannot verify or reject the hypothesis that patients who undergo internal fixation of the radial head or a replacement by a radial head prosthesis have a more favourable outcome. It is apparent that a statistically significant difference is not the same as a biologically significant difference, as most former patients rated their injured elbow as having no or only minor discomfort.

This study suggests that radiological deformities occur in a large proportion of former patients with a Mason type IV fracture, although the risk of developing a reduced joint space does not seem to be increased. These findings support previous reports, which indicate that degenerative changes are found in a majority of cases with a previous elbow fracture, but that the risk of developing a reduced joint space is small. In addition, there was no apparent correlation between the prevalence of degenerative changes that occurred in the majority of the patients and the prevalence of severe symptoms that occurred in a minority of cases. This is similar to reports following Mason type II and III fractures. Also, the risk of developing relative lengthening of the ulna, commonly referred to as an ulna plus arm with wrist problems in the formerly injured arm seemed to be low after a Mason type IV fracture, even in patients in whom a radial excision had been performed.

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In summary, even if Mason type IV fractures of the elbow are usually regarded as serious, no more than three of the

<table>
<thead>
<tr>
<th>Formerly fractured arm</th>
<th>Non-fractured arm</th>
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<tr>
<td>Elbow flexion (°)</td>
<td>140 (8)*</td>
</tr>
<tr>
<td>Elbow extension (°)</td>
<td>-10 (13)*</td>
</tr>
<tr>
<td>Forearm pronation (°)</td>
<td>80 (16)</td>
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<tr>
<td>Forearm supination (°)</td>
<td>74 (12)</td>
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<tr>
<td>Elbow valgus angle (°)</td>
<td>18 (7)*</td>
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<tr>
<td>Wrist flexion (°)</td>
<td>63 (12)</td>
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<tr>
<td>Wrist extension (°)</td>
<td>63 (12)</td>
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<td>Circumference upper arm in cm</td>
<td>30 (3)</td>
</tr>
<tr>
<td>Circumference forearm in cm</td>
<td>27 (4)</td>
</tr>
<tr>
<td>Grip strength (kp/cm²)</td>
<td>0.6 (0.3)</td>
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* p < 0.01 comparing formerly fractured and non-fractured arms
† p < 0.05
21 patients reported severe long-term symptoms. Whether preservation of the radial head or replacement with arthroplasty leads to a more favourable outcome cannot be determined by this study.

**Supplementary material**

A further opinion by Mr D. Limb is available with the electronic version of this article on our website at www.jbjs.org.uk

Financial support was provided by the Region Skåne, the Malmö and Lund University Foundations, the Pahlsson and the Herman Jarnhardt Foundations. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**References**