Uncomplicated Mason Type-II and III Fractures of the Radial Head and Neck in Adults

A Long-Term Follow-up Study

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Investigation performed at the University Hospital MAS, Malmo, Sweden

Background: The purpose of this study was to evaluate the incidence and the long-term results of closed uncomplicated Mason type-II and III fractures in a defined population of adults.

Methods: Seventy women and thirty men who were a mean of forty-seven years old when they sustained a fracture of the radial head or neck (a Mason type-II fracture in seventy-six patients and a Mason type-III fracture in twenty-four) were reexamined after a mean of nineteen years. Radiographic signs of degenerative changes of the elbow were recorded. The fracture had been treated with an elastic bandage or a collar and cuff sling with mobilization for forty-four individuals, with cast immobilization for thirty-four, with resection of the radial head in nineteen, with open reduction of the radial head in two, and with a collateral ligament repair in one. Secondary excision of the radial head was performed because of residual pain in nine patients, and a neurolysis of the ulnar nerve was performed in one patient.

Results: Seventy-seven individuals had no symptoms in the injured elbow at the time of follow-up, twenty-one had occasional pain, and two had daily pain. The injured elbows had a slight flexion deficit compared with the uninjured elbows (mean and standard deviation, 138° ± 8° compared with 140° ± 7°) as well as a small extension deficit (mean and standard deviation, –4° ± 8° compared with –1° ± 6°) ($p < 0.001$ for both). The prevalence of degenerative changes was higher in the injured elbows than in the uninjured ones (76% compared with 16%, $p < 0.001$).

Conclusions: The results following uncomplicated Mason type-II and III fractures are predominantly favorable. A secondary radial head resection is usually effective for patients with an unfavorable outcome (predominantly long-standing pain).

Levels of Evidence: Therapeutic study, Level IV (case series [no, or historical, control group]). See Instructions to Authors for a complete description of levels of evidence.

Fractures of the radial head or neck usually occur after a fall on the outstretched arm[1]. Undisplaced fractures usually result in minimal residual deficits independent of treatment[2,3], whereas displaced fractures have been described as having the risk of an unfavorable outcome[4,5]. Even if short-term follow-up does not reveal functional deficits, residual posttraumatic joint incongruity may lead to elbow osteoarthritis with increasing problems over time.

The purpose of this study was to determine the incidence and the long-term outcome of isolated, closed Mason type-II and III fractures of the radial head or neck in adults. We hypothesized that these fractures have a low incidence, minimal long-term functional deficits, and a high risk for the development of radiographic evidence of degenerative changes.

A commentary is available with the electronic versions of this article, on our web site (www.jbjs.org) and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM).

Materials and Methods

The study was performed in a city of 264,937 inhabitants, of whom 208,765 were 16.5 years of age or older in November 1970. The incidence of a defined fracture within this population could be determined retrospectively as virtually all patients with a fracture are seen at the trauma unit at the only emergency hospital in the city. City residents who sustain a fracture elsewhere are later referred to the orthopaedic department for follow-up, and at this visit the fracture is classified and entered into the hospital registry. With this relatively comprehensive case documentation system, it is possible to retrospectively identify individuals with a specific type of fracture sustained over a specified period of time. Additionally, all

radiographs and reports have been saved in the archives of the hospital for the past half-century; therefore, the fracture type can be reevaluated and reclassified retrospectively with use of the primary radiographs. Fewer than 3% of all city residents who sustain a fracture are cared for outside of this hospital system and thus are not included in the hospital registry.

Seven hundred and fifty-six individuals who sustained a radial head or neck fracture between 1969 and 1979 were identified in the hospital registry. All patients with a Mason type-II or III fracture who were still living in the city were invited to return for reexamination, at a mean of nineteen years (range, fourteen to twenty-five years) after the injury. No patient had another major fracture or soft-tissue injury associated with the proximal radial fracture. Of the 131 individuals still living in Malmo, seven refused to participate in the study (an attendance rate of 95%) and twenty-four had been children (younger than 16.5 years of age) at the time of injury and thus were excluded. One hundred individuals who had been 16.5 years of age or older at the time of the fracture were included in the study. The subjective results for all 100 individuals were evaluated with a questionnaire, and seventy-five also returned for a clinical and radiographic evaluation.

Seventy patients were women, and thirty were men. The mean age was forty-seven years (range, eighteen to seventy-three years) at the time of the injury. Seventy-seven injuries were the result of low-energy trauma, defined as a fall or direct impact, and twenty-two were caused by high-energy trauma, defined as a fall from >2 m or a motor-vehicle accident. Information regarding the injury mechanism was missing for one patient. The left elbow was affected in forty-eight patients and the right elbow, in fifty-two. There were seventy-six Mason type-II fractures, twenty-three of which were radial neck fractures, and twenty-four Mason type-III fractures, five of which were radial neck fractures.

Primary treatment included an elastic bandage or a collar and cuff sling with mobilization as soon as the pain allowed for forty-four patients (forty-one Mason type-II fractures and three Mason type-III fractures; thirty radial head fractures and fourteen radial neck fractures), cast immobilization for a median of two weeks (range, one to three weeks) for thirty-four patients (twenty-eight Mason type-II fractures and six Mason type-III fractures; twenty-eight radial head fractures and six radial neck fractures), acute radial head excision in nineteen patients (four Mason type-II fractures and fifteen Mason type-III fractures; twelve radial head fractures and seven radial neck fractures), open reduction of the radial head fracture prior to plaster cast immobilization in two patients (two Mason type-II, radial head fractures), and a repair of the medial collateral ligament in one patient (a Mason type-II, radial neck fracture). The method of treatment was chosen according to the preference of the surgeon on call when the patient presented with the fracture. No complications were recorded during or after the surgery. Nine patients (six Mason type-II fractures and three Mason type-III fractures; eight radial head fractures and one radial neck fracture) had a secondary radial head resection, after a mean of thirteen months (range, two to forty-one months), because of residual pain, and one patient (a Mason type-II, radial neck fracture) underwent neurolysis of the ulnar nerve three years after injury.

The subjective outcome was assessed with a questionnaire that evaluated activities of daily living; elbow pain on loading and at rest; and tenderness, loss of strength, and range of motion of the affected elbow. Strength, range of motion, and pain in the wrist and hand of the injured extremity were also evaluated. The uninjured arm served as the control.

Seventy-five former patients returned for clinical examination, which was performed by two of the authors who had not been involved in the treatment of the patients. 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 with a Martin vigorimeter (Werkstätten für Medizinmechanik; Heinrich C. Ulrich, Ulm-Donau, Germany), and the circumference of the arm 10 cm proximal to the tip of the olecranon and the circumference of the forearm 10 cm distal to the tip of the olecranon were measured with a tape measure. The uninjured arm served as the control. The difference in the strength of elbow flexion and extension between the two sides was estimated by subjective comparison of the elbows. The Tinel test in the cubital tunnel was performed in both elbows. The outcome was also graded according to the classification system of Steinberg et al.[6], with the understanding that that classification system was developed for children. According to the system, a good result corresponds to full mobility and no pain in the elbow; a fair result, to <20° of loss of motion in any direction on objective examination or slight pain; and a poor result, to ≥20° of loss of mobility in any direction or pain at rest.

On the basis of the primary radiographs, the fractures were classified as involving the radial head or radial neck and according to the classification described by Mason and later modified by Broberg and Morrey[7] (Fig. 1). This classification was performed by a radiologist with no knowledge of the treatment or the subjective or clinical outcome. Follow-up radiographs included anteroposterior and lateral projections of the elbows. Subchondral cysts, subchondral sclerosis, and/or osteophytes were defined as degenerative changes, and the number of individuals with more than a 1-mm reduction in the joint space in comparison with the joint space in the uninjured elbow was recorded[8]. The diameter of the radial head and miscellaneous pathological entities, such as nonunion, avascular necrosis, proximal radioulnar synostosis, and periarticular ossification, were also documented. The uninjured elbows served as controls.

The study was approved by the ethical committee of the university hospital. Comparisons of values for the two arms of the same individual were performed with the Student t test between pairs and the chi-square test, with $p < 0.05$ indicating a significant difference. Data are presented as the mean and the range or the mean and the standard deviation.

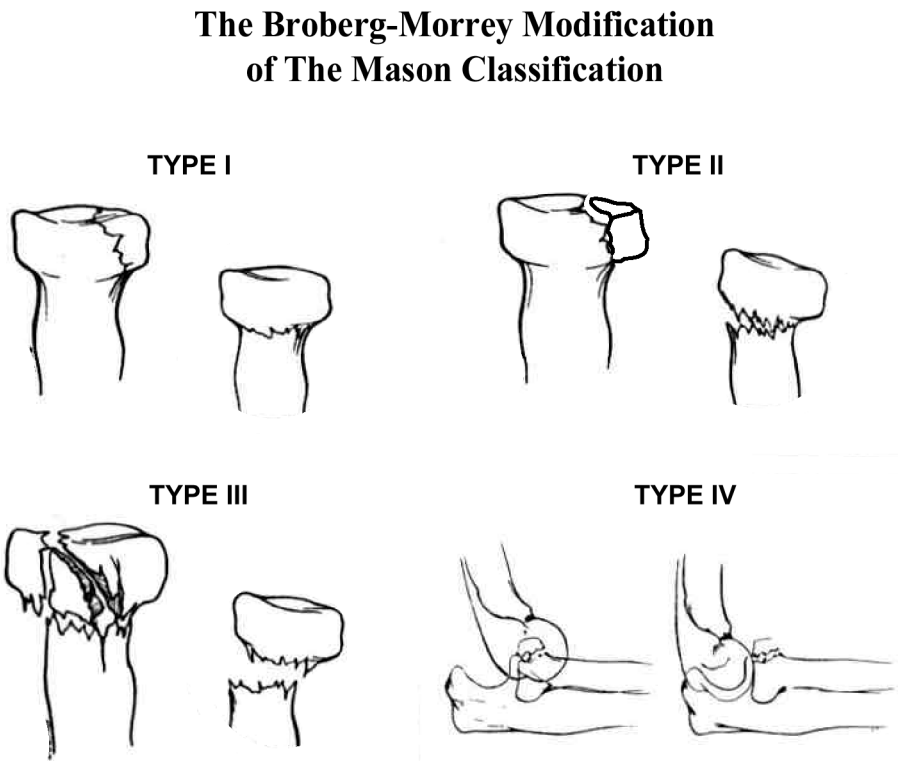

Fig. 1
The Broberg-Morrey modification[7] of the Mason classification of radial head and neck fractures. Type I = fracture of the radial head or neck displaced <2 mm, Type II = fracture of the radial head or neck displaced ≥2 mm and involving ≥30% of the joint surface, Type III = comminuted fracture of the radial head or neck, and Type IV = elbow dislocation with any of the above fracture types. (By permission of the Mayo Foundation.)

Results

Between 1969 and 1979, 2965 patients sustained an elbow fracture. Seven hundred and fifty-six (26%) of these patients sustained a fracture of the radial head or neck, with 480 (64%) sustaining a Mason type-I fracture; 222 (29%), Mason type-II; thirty-six (5%), Mason type-III; and eighteen (2%), Mason type-IV. Six hundred and seventy-two (89%) of the individuals with a radial head or neck fracture were 16.5 years of age or older at the time of the fracture. Thus, the annual incidence of fractures of the radial head or neck was 2.9 per 10,000 individuals of 16.5 years of age or older at the time of the fracture.

Of the 100 individuals included in the follow-up evaluation, seventy-seven had no symptoms in the previously fractured elbow; twenty-one (twelve Mason type-II fractures and nine Mason type-III fractures; seventeen radial head fractures and four radial neck fractures) had occasional but not daily pain, mainly when lifting heavy objects; and two (one Mason type-II fracture and one Mason type-III fracture; both radial head fractures) had daily pain (one of whom had pain at rest). Twelve individuals had a subjectively reduced range of motion of the previously injured elbow, and five also noted weakness and numbness in the hand of the previously injured extremity.

The previously injured elbows had less flexion (138° ± 8° compared with 140° ± 7°; $p < 0.001$) and less extension (−4° ± 8° compared with −1° ± 6°; $p < 0.001$) than did the uninjured elbows, and there was less supination of the forearm on the injured side (83° ± 11° compared with 86° ± 6°; $p < 0.01$) (Table I). Nineteen previously fractured elbows had a positive Tinel sign over the ulnar nerve compared with eight of the unfractured elbows ($p < 0.05$). According to the Steinberg classification, 84% of the outcomes were classified as good; 11%, as fair; and 5%, as poor.

The previously injured elbows had more degenerative changes seen on radiographs than did the uninjured elbows, with cysts in forty-six injured elbows compared with nine uninjured elbows, irregular subchondral bone in fifty compared with eleven, and osteophytes in forty-two compared with nine. The prevalence of degenerative changes was 76% in the injured elbows compared with 16% in the uninjured elbows. All differences were significant ($p < 0.001$). Eight previously fractured elbows had a reduction in the joint space of >1 mm compared with the joint space in the uninjured elbow, and six uninjured elbows had a reduction in the joint space of >1 mm compared with the joint space in the previously fractured elbow. On the average, the radial head diameter in the extremities with a previously injured elbow was larger than that in the uninjured extremities (24 ± 2 mm compared with 22 ± 2 mm, $p < 0.001$). No cases of nonunion, avascular necrosis, proximal radioulnar synostosis, or periarticular ossification were identified.

Of the nine patients with a secondary radial head excision performed to treat residual pain, only three subjectively rated the injured elbow as being as good as the uninjured one at the time of follow-up; however, none classified the previously fractured elbow as poor. When these results were compared with the outcomes for the nineteen patients with primary radial head excision, twelve of whom subjectively rated the previously injured elbow as being as good as the uninjured one, the difference was not significant, with the numbers available.

TABLE I Results in Seventy-five Individuals Who Sustained a Fracture of the Radial Head or Neck After the Age of Sixteen Years*

	Arm with Previous Elbow Fracture	Arm with No Fracture
Range of motion *(deg)*		
Elbow flexion	138 ± 8†	140 ± 7
Elbow extension	–4 ± 8†	–1 ± 6
Forearm pronation	87 ± 7	87 ± 7
Forearm supination	83 ± 11†	86 ± 6
Elbow valgus angle	10 ± 5§	9 ± 6
Wrist flexion	69 ± 12	69 ± 12
Wrist extension	62 ± 12	63 ± 11
Circumference *(cm)*		
Upper arm	28 ± 3	28 ± 3
Forearm	26 ± 3	26 ± 3
Grip strength (kPa/cm^2)	0.7 ± 0.4	0.7 ± 0.4

*The values are given as the mean and the standard deviation. †$P < 0.001$ for the difference between the previously fractured and nonfractured arms. ‡$P < 0.01$ for the difference between the previously fractured and nonfractured arms. §$P < 0.05$ for the difference between the previously fractured and nonfractured arms.

Discussion

Twenty-five percent of all elbow fractures in this urban population were isolated radial head or neck fractures. Eighty-nine percent of the radial head and neck fractures were sustained by individuals 16.5 years of age or older, so the annual incidence was 2.9 per 10,000 individuals in this age group. The outcome of an isolated Mason type-II or III fracture of the radial head or neck is predominantly favorable up to twenty-five years after the injury, with no increased prevalence of reduced joint space in the previously injured elbow.

The strength of this study is that we were able to obtain reliable epidemiological data by using an existing fracture registry. The registry enabled us to identify most of the fractures within the defined population, even when a fracture had been sustained twenty-five years earlier[9]. If fracture incidence is determined only with use of a questionnaire, the number of fractures can be underreported by 40% or overreported by 20%[10]. Also, the follow-up period in our study was one of the longest published to date, our sample size was larger than that in most previous studies, and we performed an additional radiographic evaluation of most of the former patients (Figs. 2-A and 2-B). The weakness of the study is that the treatment was not randomized. This is an important limitation since, although the treatment was somewhat consistent, it certainly was not standardized. There also is a possibility of detection bias in the way in which the range-of-motion and other outcome measures were obtained during the examination.

Our findings are in accordance with those in the published literature. Arner et al.[3] and Poulsen and Tophöj[2] reported that 99%[3] and 95%[2] of individuals with a radial head or neck fracture had a good or excellent outcome. However, Mason type-I fractures were included in those reports, so a comparison with the current study must be done with caution. Of 239 individuals with a Mason type-II or III fracture in the study by Arner et al., two had a poor outcome, as classified with the Steinberg classification[6]. Of thirty patients with such a fracture in the study by Poulsen and Tophöj, two had a poor result, defined as reduced working ability and/or limitation of motion exceeding 10° in one or more directions.

A reduced range of motion, usually described as a stiff elbow, is a common symptom after elbow trauma, and Morrey et al.[11,12] and other authors[5,13-15] have suggested that patients often have complaints when an elbow extension deficit exceeds 30° and/or elbow flexion is <130°. Other authors have suggested that patients have subjective complaints when the extension deficit exceeds 20°[6], and even an extension deficit exceeding 10° has been described as a poor outcome[2]. In our series, decades after the injury, the patients had a mean residual deficit of 2° in elbow flexion, 3° in elbow extension, and 3° in supination compared with the ranges of the uninjured elbow. These deficits are smaller than those in several other studies[5,16], perhaps because only uncomplicated Mason type-II and III fractures were included in our study or because of our longer follow-up period. Only four patients in the current study had a loss of extension of ≥20°, a deficit that Steinberg et al. defined as a poor outcome[6]. However, none of these four individuals had pain at rest, although two had occasional pain. According to the Steinberg classification, 84% of the results in our study should be classified as good; 11%, as fair; and 5%, as poor. The poor results were due to an extension deficit of ≥20° in four patients and to pain at rest in one.

The outcome of the primary treatment must be classified as poor in the ten patients who needed a secondary operation because of persistent pain following the fracture. There was a nonsignificant tendency for the patients with secondary excision of the radial head to have an inferior outcome: 67% had minor complaints compared with 37% of those who had had a primary excision. These data raise the question of whether a secondary excision of the radial head produces a less favorable outcome than does a primary excision. An alter-

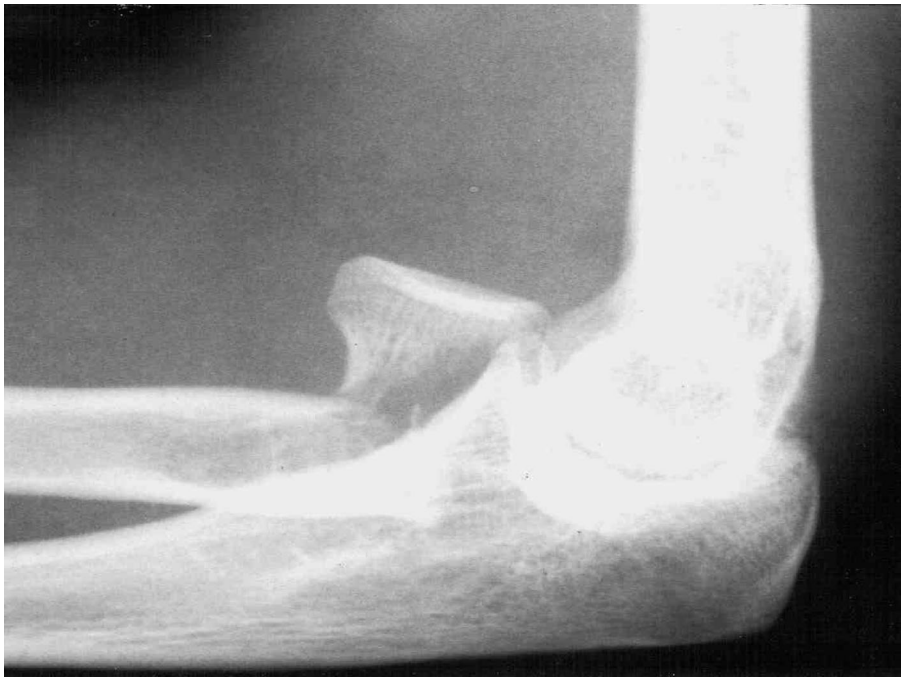

Fig. 2-A

Radiograph of a thirty-three-year-old woman, made after a dislocated, closed fracture of the radial neck was treated primarily with radial head excision.

native explanation is that individuals who need a later excision of the radial head had a different type of fracture than those treated with a primary operation, but this hypothesis cannot be verified in this study. It seems that a simple radial head excision, regardless of when it is done, results in a clinically acceptable long-term outcome in the majority of patients. This notion is supported by the great majority of published studies[2,13,16-19]. However, most of these studies included few individuals, had a short to medium-term follow-up, and varied with regard to the classification system that was used, so comparison between studies is difficult. In contrast, other studies have demonstrated unfavorable outcomes after radial head excision. Ikeda and Oka[5] reported an average extension deficit of 25° in individuals who had undergone primary radial head excision following a Mason type-II or III fracture. However, all of the cited studies comparing the outcomes of primary and late excisions of the radial head following a Mason type-II or III fracture, including the current study, must be regarded with skepticism, and all conclusions should be drawn with caution. The evaluated fracture cohorts were small, resulting in a high chance of a type-II error, and the extent of the associated soft-tissue injuries was not always described. Additional long-term studies of a larger sample of patients should be performed to compare the outcomes of primary and secondary radial head excisions.

The present study also supports previous findings that radiographically evident deformity develops in most patients with a fracture of the radial head or neck[18,20,21]. We found degenerative changes in 76% of the previously injured elbows. However, there was apparently no correlation between these radiographic degenerative changes and pain or loss of motion, which occurred in only a minority of patients. The radio-

Fig. 2-B

At the time of follow-up, eighteen years after the fracture, there were no signs of elbow osteoarthritis.

graphically visible enlargement of the radial head also seems to be of minor clinical relevance as does the radiographic appearance of a reduced joint space.

In summary, isolated closed Mason type-II or III fractures of the radial head or neck in adults usually have a favorable long-term outcome. This is also true for patients treated with either a primary or a secondary radial head excision. We did not identify a less favorable outcome in individuals who had a secondary procedure, including a radial head excision due to persistent pain, but more studies with a larger sample size are needed to answer this question. We concluded that the long-term outcome of a Mason type-II or III radial head or neck fracture in an adult is favorable when the treatment strategies that we described are used. ■

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