Primary Nonoperative Treatment of Moderately Displaced Two-Part Fractures of the Radial Head

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Background: Moderately displaced two-fragment fractures of the radial head have been treated predominantly nonoperatively. Recently, however, open reduction and internal fixation has gradually gained interest, without clear evidence that initial nonoperative treatment leads to an unfavorable outcome. As a consequence, the purpose of the present study was to evaluate the long-term outcome after the initial nonoperative treatment of this type of fracture.

Methods: Fifteen men and thirty-four women, with a mean age of forty-nine years at the time of the injury, were included in the study. All patients initially had been managed nonoperatively for a two-fragment fracture of the radial head that was displaced 2 to 5 mm and that included ≥30% of the joint surface (a Mason type-IIa fracture). Early mobilization had been used for twenty-seven patients, and cast immobilization for a mean of two weeks (range, one to four weeks) had been used for twenty-two. All patients were reevaluated with a questionnaire after a mean of nineteen years, and thirty-four also had a clinical and a radiographic evaluation. Six patients had had a delayed radial head excision because of an unsatisfactory primary outcome.

Results: Forty of the forty-nine patients had no subjective complaints, eight were slightly impaired as the result of occasional elbow pain, and one had daily pain. Flexion was slightly impaired in the injured elbows as compared with the uninjured elbows (137° ± 8° compared with 139° ± 7°), as was extension (–3° ± 7° compared with 1° ± 5°) and supination (86° ± 7° compared with 88° ± 4°) ($p < 0.05$ for all comparisons). The prevalence of degenerative changes on radiographs was higher for the injured elbows than for the uninjured elbows (82% [twenty-eight of thirty-four] compared with 21% [seven of thirty-four]; $p < 0.01$).

Conclusions: The initial nonoperative treatment of Mason type-IIa fractures of the radial head that are displaced by 2 to 5 mm is associated with a predominantly favorable outcome, especially if a delayed radial head excision is performed in the few cases in which the early outcome is unsatisfactory.

Level of Evidence: Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

Fractures of the radial head most often occur as the result of a fall on the outstretched arm[1,2]. The long-term outcome associated with undisplaced and minimally displaced fractures, independent of the method of treatment, consistently has been described as excellent[3-5]. In contrast, the outcome following displaced and comminuted fractures has not been as consistent, with some studies demonstrating a high proportion of unfavorable results[6-8] and other studies demonstrating predominantly favorable results[3,5,9-12]. As a result of the uncertainty regarding the long-term results, open reduction and internal fixation of the radial head has received more interest during the last decade, predominantly for the treatment of displaced two-fragment fractures[13-17].

Some previous investigators have reported on Mason type-II fractures only but have combined radial head and neck fractures, whereas others have reported on radial head fractures only but have combined Mason type-II and III fractures[7,8,10,11,14,17]. Combining fracture patterns in this way can lead to unclear results. For example, a displaced intraarticular fracture (such as a radial head fracture) with residual joint incongruity can have an inferior long-term outcome in comparison with a displaced extraarticular fracture (such as a radial neck fracture)[18]. In addition, a comminuted fracture of the proximal part of the radius (a Mason type-III fracture) can have a worse outcome in comparison with a Mason type-II two-part fracture because type-III fractures are more often associated

with a high-energy mechanism of injury[19]. To our knowledge, the present study is the first study to specifically evaluate the long-term outcome associated with the nonoperative treatment of moderately displaced two-fragment fractures of the radial head, a fracture type about which there is current controversy regarding treatment.

Materials and Methods

The study was approved by the Ethics Committee of Lund University in Sweden. Malmö, Sweden had 264,937 inhabitants in November 1970. The city has one emergency hospital, and virtually all patients with a fracture attend the emergency-care clinic at the hospital. In a previous study on a cohort of seventy patients with a fracture, only two fractures (including one fracture at the tip of the lateral malleolus and one small foot fracture) were treated at a private facility and were not registered in the hospital archives[20]. Furthermore, city residents who sustain a fracture elsewhere are later referred to the orthopaedic department for follow-up, at which time the fracture is entered into the hospital registry. In addition, as all radiographs, referrals, and reports have been saved in the archives of the hospital for the past half century, fractures can be reevaluated and reclassified retrospectively on the basis of the primary radiographs[21].

In this retrospective, observational follow-up study, a review of the radiographs for all Malmö citizens who had sustained any type of elbow fracture during the years 1969 to 1979 revealed that 756 of these patients had sustained a radial head or neck fracture. One hundred and thirty-one former patients with a Mason type-II or III fracture (see Appendix), that is, a simple fracture without elbow dislocation, who were still living in the Malmö region were identified through the national computer files with use of the personal ten-digit identity number used by every Swede from birth to death. Of the 131 patients who were invited to participate in this follow-up study at a mean of nineteen years (range, fourteen to twenty-five years) after the injury, seven patients (all of whom had a Mason type-IIb or III fracture) declined to participate, for a follow-up rate of 95%. All fifty-three patients with a two-fragment fracture of the radial head that involved ≥30% of the joint surface with ≥2 mm of displacement (a Mason type-IIa fracture) agreed to participate. We chose not to include patients with a Mason type-IIb fracture (a fracture of the radial neck with ≥2 mm of displacement) as this type of fracture is less commonly treated with open reduction and internal fixation[8,22]. We excluded three individuals who had been treated primarily surgically (all of whom had 3 mm of fracture displacement) and one outlier (a patient who was managed nonoperatively in spite of having 15 mm of fracture displacement). The remaining forty-nine patients included fifteen men and thirty-four women who had had a mean age of forty-nine years (range, eighteen to seventy-two years) at the time of the fracture. At a mean of nineteen years (range, fourteen to twenty-four years) after the injury, they answered a questionnaire regarding the subjective results (see Appendix). In addition, thirty-four individuals underwent a clinical and radiographic

Fig. 1-A

Fig. 1-B

Figs. 1-A through 1-D A sixty-one-year-old woman sustained a displaced, closed fracture of the radial head that was treated primarily nonoperatively.

Figs. 1-A and 1-B Anteroposterior (Fig. 1-A) and lateral (Fig. 1-B) radiographs of the elbow, made on the day of the injury. After five months, a delayed radial head excision was performed because of persistent pain.

examination. None of the patients had had other major fractures or soft-tissue injuries involving the elbow.

The right elbow was affected in twenty-four patients, and the left elbow was affected in twenty-five. Low-energy trauma (defined as a fall or a direct impact) was the cause of the fracture in thirty-seven patients, and high-energy trauma (defined as a fall from >2 m or a motor-vehicle accident) was the cause in eleven; information regarding the type of trauma was missing from the record of one patient. Primary treatment had consisted of wrapping the elbow with an elastic bandage or the use of a collar and cuff sling, with mobilization as soon as the pain allowed, for twenty-seven patients and cast immobilization for a mean of two weeks (range, one to four weeks) for twenty-two patients.

A delayed radial head excision was performed for six patients (four men and two women) who had had a mean age of forty-four years (range, thirty-four to sixty-one years) at the time of fracture. Three of these patients had sustained the fracture in the right elbow, and three had sustained the fracture in the left elbow. Three had experienced high-energy trauma, two had had low-energy trauma, and the type of trauma was unknown for one patient. Three patients had been managed with cast immobilization for a mean of three weeks (range, two to four weeks), whereas three had been managed with early mobilization. The fractures had a mean displacement of 3 mm (range, 2 to 4 mm), and the delayed radial head excision was performed after a mean of five months (range, four to six months).

The subjective outcome was assessed with a questionnaire that evaluated elbow pain on loading and at rest, tenderness, range of motion, stability, and strength in the affected elbow (see Appendix). Strength, range of motion, and sensibility in the wrist and hand were also evaluated. The uninjured arm served as the control. Clinical examination was performed by two of the authors (M.K.K. and R.H.) who had not been involved in the treatment of the patients. Flexion and extension of the elbow and wrist, pronation and supination of the forearm, and the angle of the extended elbow were measured with a goniometer. Grip strength was evaluated with a Martin vigorimeter (Werkstätten für Medizinmechanik; Heinrich C. Ulrich, Ulm-Donau, Germany), and the circumferences of the arm and forearm were measured with a tape measure 10 cm proximal and distal to the tip of the olecranon. The uninjured arm served as the control. The difference in the strength of elbow flexion and extension between the two sides was estimated by means of a comparison of the elbows, and the strength on the injured side was subjectively classified by the investigator as decreased, similar, or increased as compared with the strength on the uninjured side. The Tinel test was performed at the cubital tunnel for both elbows.

On the basis of the primary radiographs, which were available for all patients, the fractures were classified according to the system of Mason as modified by Broberg and Morrey (see Appendix)[8,22]. This classification was performed by a radiologist (J.B.) with no knowledge of the treatment or the subjective or clinical outcome. Follow-up radiographs included anteroposterior and lateral projections of the elbow. Subchondral cysts, subchondral sclerosis, and/or osteophytes

Fig. 1-C

Fig. 1-D

Anteroposterior (Fig. 1-C) and lateral (Fig. 1-D) radiographs made after sixteen years of follow-up, at which time the patient had no subjective complaints.

TABLE I Clinical Findings for Thirty-four Patients Who Had Had Primary Nonoperative Treatment of a Displaced Fracture of the Radial Head

	Formerly Fractured Arm*	Nonfractured Arm*
Elbow flexion *(deg)*	137 ± 8†	139 ± 7
Elbow extension *(deg)*	–3 ± 7†	1 ± 5
Forearm pronation *(deg)*	87 ± 7	87 ± 7
Forearm supination *(deg)*	86 ± 7‡	88 ± 4
Elbow valgus angle *(deg)*	10 ± 4‡	8 ± 3
Wrist flexion *(deg)*	70 ± 11	70 ± 11
Wrist extension *(deg)*	60 ± 10†	63 ± 9
Circumference of arm *(cm)*	28 ± 3	28 ± 3
Circumference of forearm *(cm)*	26 ± 2	26 ± 2
Grip strength *(kp/cm2)*	0.6 ± 0.4	0.7 ± 0.4

*The values are given as the mean and the standard deviation as determined after a mean duration of follow-up of nineteen years. †$p < 0.01$ as compared with the nonfractured arm. ‡$p < 0.05$ as compared with the nonfractured arm.

were defined as degenerative changes. The joint space was measured, and a >1-mm reduction in the joint space was recorded. We measured the height of the joint space with a ruler to the nearest millimeter as the distance between the distal part of the humerus and the proximal part of the ulna medially and between the distal part of the humerus and the head of the radius laterally as seen on the anteroposterior projection. In individuals who had been managed with a delayed radial head excision, we only measured the height of the joint space in the medial compartment. The diameter of the radial head and miscellaneous pathological entities such as nonunion, osteonecrosis, proximal radioulnar synostosis, and periarticular ossification were also documented.

Statistical Methods

Comparisons of the values for the two arms of the same individual were performed with use of the Student t test between pairs and with use of the chi-square test, with the level of significance set at $p < 0.05$. Data are presented as the mean and the range or the mean and the standard deviation.

Results

Subjectively, forty (82%) of the forty-nine patients had no elbow complaints. Eight of the forty-nine patients experienced minor impaired function. In five cases, this was manifested by occasional pain with loading. One patient had occasional pain at rest. Five patients had subjective weakness and reduced range of motion of the elbow. Only one patient had severely impaired function (daily pain both with loading and at rest but with no reduction in the range of motion). Of the six patients with a delayed radial head excision, four had minor functional impairment and two had no complaints (Figs. 1-A through 1-D).

The thirty-four patients who underwent a clinical evaluation had slight limitation in terms of flexion, extension, and supination when the formerly injured elbows were compared with the uninjured elbows. Furthermore, the valgus angle was slightly greater and extension at the wrist was slightly less when the injured side was compared with the uninjured side (Table I). The mean range of motion of the elbow was 134° (range, 105° to 150°) on the injured side and 140° (range, 120° to 155°) on the uninjured side ($p < 0.01$), and the mean rotation of the forearm was 173° on the injured side (range, 145° to 190°) and 175° (range, 150° to 190°) on the uninjured side ($p = 0.06$). No differences were found between the formerly injured and uninjured sides with regard to elbow strength, circumference of the arm and forearm, or the flexion and grip strength in the hand (Table I). Tinel's test over the cubital tunnel was positive in seven of the thirty-four previously injured elbows and in four of the thirty-four uninjured elbows. This difference was not significant.

Radiographic evaluation revealed that the prevalence of degenerative changes was greater in formerly injured elbows than in noninjured elbows (82% [twenty-eight of thirty-four] compared with 21% [seven of thirty-four]). Specifically, cysts were seen in twenty-three (68%) of the thirty-four formerly injured elbows, compared with only four (12%) of the thirty-four uninjured elbows; irregular subchondral bone with sclerosis was seen in twenty-seven injured elbows (79%), compared with six uninjured elbows (18%); and osteophytes were seen in twenty-three injured elbows (68%), compared with five uninjured elbows (15%). All three of these differences were significant ($p < 0.001$). Two formerly injured elbows and five uninjured elbows had a joint-space reduction of >1 mm; this difference was not significant. The mean size of the radial head was larger in the formerly injured elbows than in the uninjured elbows (24 ± 2 compared with 23 ± 2 mm; $p < 0.01$). There were no cases of nonunion, osteonecrosis, proximal radioulnar synostosis, or periarticular ossification.

Discussion

The present study demonstrates that nonoperative treatment of two-fragment fractures of the radial head that are associated with 2 to 5 mm of displacement can provide a good or excellent long-term functional outcome in the vast majority of cases. The objectively determined slightly limited range of motion and the higher prevalence of radiographic degenerative changes in the formerly injured elbows were of minor clinical importance. The favorable outcome seen in the present study could be related to the fact that we focused on a defined subgroup of radial head fractures, in contrast with most other studies. Arner et al., in a study of 186 patients who were managed nonoperatively for a radial head fracture, reported normal mobility and no remaining symptoms in 164 patients (88%) at one to fifteen years after the injury[3]. However, that study included patients with undisplaced fractures. Bakalim, in a study of fifty-nine patients who were managed nonoperatively for a displaced radial head fracture, reported a good outcome for forty-seven patients (80%) at a mean of nine years after the injury[9], and Poulsen and Tophoj, in a study of twenty-one patients who were managed with a plaster cast followed by mobilization as soon as the pain subsided for a radial head fracture that was displaced by >1 mm, reported an excellent outcome, with no subjective complaints and no loss of motion, in nineteen patients at a mean of 5.2 years after the injury[5]. However, other reports have contradicted those results. Mason, in a study involving a cohort of twenty patients who were managed nonoperatively for a displaced radial head fracture, reported a good outcome in only ten patients at a mean of 2.2 years after the injury[8], and Murray, in a study involving a cohort of thirty patients who were managed nonoperatively for a displaced radial head fracture, reported a good outcome in only eleven patients at a mean of 2.5 years after the injury, which was the same proportion of patients with a good outcome as was noted following primary operative treatment[23].

Because of the inconsistency of these reports, open reduction and internal fixation has gained more and more interest during the last decade as the primary treatment for displaced radial head fractures[13-17]. But does open reduction and internal fixation really improve the outcome? Ring et al., in a study of fifty-six patients in whom several types of radial head or neck fractures were treated with open reduction and internal fixation, reported a mean elbow range of motion of 119° and a mean forearm rotation of 144° at a mean of four years after the injury[17]. In the thirty individuals who had had a Mason type-II fracture[17], only half had no pain at the time of follow-up. These results are not as good as the ones reported here. However, it is difficult to directly compare the two studies because Ring et al. used the original Mason classification system[8] whereas we used the Mason system as modified by Broberg and Morrey[22]. The results of the study by Geel et al., which included nineteen patients who were followed for a mean of one year after the injury, are difficult to compare with the results of the present study because that study included both radial head and neck fractures[14]. A good or excellent result (according to the Broberg-Morrey elbow score) was found in all patients with a Mason type-II radial head fracture that had been treated with open reduction and internal fixation in one report of eleven patients who were followed for a mean of 7.3 years[13] and in another cohort of eight patients who were followed for a mean of 2.7 years[15]. Pearce and Gallannaugh, in a study involving a cohort of nineteen patients with a Mason type-II fracture of the radial head that was treated with open reduction and internal fixation, reported an excellent outcome for sixteen patients (84%) at a mean of 2.3 years after the injury on the basis of a similar assessment score[16]. Finally, Khalfayan et al., in a study in which a similar elbow score was used to compare the results of operative and nonoperative treatment of Mason type-II fractures of the radial head after a mean duration of follow-up of 1.5 years, reported a good or excellent outcome for fourteen of the sixteen patients in the operative treatment group, compared with only four of the ten patients in the nonoperative treatment group[24]. However, because of the small sample sizes, it is difficult to draw any firm conclusions from the four studies.

With regard to the results of primary nonoperative treatment in the current cohort, six of the forty-nine patients (the six who underwent a delayed radial head excision) must be graded as having an unfavorable primary outcome. However, the unfavorable primary outcome was improved when a delayed radial head excision was performed as none of these patients rated the formerly injured elbow as severely impaired at the time of follow-up. In fact, two patients actually reported no remaining symptoms at the time of the final follow-up. Because of the small sample size, it is difficult to draw any definite conclusions regarding the efficacy of a delayed radial head excision after a radial head fracture on the basis of the present study. Although somewhat controversial, most studies that have evaluated the outcome following radial head excision have demonstrated an acceptable result after this procedure[12,22,25-27]. In addition, Herbertsson et al. enhanced our understanding by reporting that the outcome of delayed radial head excision was not inferior to that of primary excision following a fracture[12]. It also should be noted that previously described complications following a radial head excision, such as radioulnar synostosis, proximal migration of the radius, and cubitus valgus[25,26,28-30], were not found in the present study, further supporting the efficacy of delayed radial head excision as a secondary procedure in cases of an unfavorable primary outcome following a radial head fracture.

The main strength of the present study is that it specifically presents the results of nonoperative treatment of moderately displaced two-fragment fractures of the radial head, a type of fracture that could be subjected to open reduction and internal fixation. Furthermore, we only included moderately displaced radial head fractures, whereas other studies have included even more displaced fractures, comminuted fractures, and even radial neck fractures. To our knowledge, this could be one reason why the results of the present study were superior to those of most other studies. This is the largest cohort of moderately displaced Mason type-IIa radial head fractures with the longest period of both clinical and radiographic follow-

up. The weaknesses of the present study are its nonrandomized design, making it impossible to directly compare nonoperative and operative treatment, and the fact that comparison with previous studies in the literature is difficult because those studies involved different fracture populations and used different outcome scores.

We conclude that nonoperative treatment of two-fragment fractures of the radial head with 2 to 5 mm of displacement is associated with a predominantly good or excellent long-term outcome, especially if a delayed radial head excision is performed for the few patients who have an unsatisfactory primary outcome. The outcome does not seem inferior to the outcome described in the literature after open reduction and internal fixation. Thus, we cannot support the use of open reduction and internal fixation as the standard treatment of this type of fracture.

Appendix

eA The Broberg-Morrey modification of the Mason system for the classification of radial head and neck fractures and the questionnaire that was used in the study are available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

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