SCIENTIFIC ARTICLE

Treatment of Mason Type II Radial Head Fractures Without Associated Fractures or Elbow Dislocation: A Systematic Review

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Purpose There is no consensus as to the best treatment of Mason type II fractures without concomitant elbow fractures or dislocation. The aim of this systematic review was to compare the results of operative and nonoperative treatment of these injuries.

Methods We systematically screened the databases of PubMed, EMBASE, and Cochrane Library until September 2011 for studies on nonoperative or operative treatment of Mason type II fractures. We defined successful treatment as an excellent or good result according to the Broberg and Morrey score, Mayo Elbow Performance Score, or Radin score. Exclusion criteria were duration of follow-up of less than 6 months, an improperly described therapy or combination of therapies, skeletal immaturity, and articles written in languages other than English.

Results Among 717 studies, 9 retrospective case series (level IV) describing 224 patients satisfied our inclusion criteria. Nonoperative treatment was successful in 114 of 142 patients (80%) pooled from the studies (42% to 96% success in individual studies). Open reduction and internal fixation was successful in 76 of 82 patients (93%) (81% to 100% success in individual studies).

Conclusions Only a few studies with a low level of evidence address the treatment of isolated, displaced, partial articular fractures. There is a need for sufficiently powered randomized, controlled trials.

Clinical relevance There is insufficient evidence to draw firm conclusions on the optimal treatment of isolated, displaced, partial articular Mason type II fractures. *(J Hand Surg 2012; 37A:1416–1421. Copyright © 2012 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Elbow, fracture, radial head, review, trauma.

RADIAL HEAD FRACTURES are common, with an estimated incidence of 2.5 to 2.9 per 10,000 people per year, and accounting for approximately one-third of all elbow fractures.[1–3] Several classifications have been introduced to describe radial head fractures, nearly all derived from the classification introduced by Mason in 1954.[4–8] A Mason type I fracture is a fissure or marginal sector fracture without displacement. Type II fractures are articular fractures involving a part of the head with displacement. Comminuted articular fractures involving the whole head of the radius are Mason type III fractures.[5] Mason did not define

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TABLE 1. Broberg and Morrey Elbow Score

Variable	Point Value	Description
Motion	27	Degree of flexion (0.2 × arc)
	6	Degree of pronation (0. 1 × arc)
	7	Degree of supination (0. 1 × arc)
Strength	20	Normal
	13	Mild loss (appreciated but not limiting, 80% of opposite side)
	0	Severe loss (limits everyday tasks, disabling)
Stability	5	Normal
	4	Mild loss (perceived by patient, no limitation)
	2	Moderate loss (limits some activity)
	0	Severe loss (limits everyday tasks)
Pain	35	None
	28	Mild (with activity, no medication)
	15	Moderate (with or after activity)
	0	Severe (at rest, constant medication, disabling)

A score of 95 to 100 points is excellent; 80 to 94 points is good; 60 to 79 points is fair; and 0 to 59 points is poor.[11]

TABLE 2. Mayo Elbow Performance Score

	Point Value	Description
Pain	45	None
	30	Mild
	15	Moderate
	0	Severe
Motion arc	20	> 100°
	15	50° to 100°
	5	< 50°
Stability	10	Stable
	5	Moderate instability
	0	Gross instability
Daily function	5	Comb hair
	5	Feed self
	5	Hygiene
	5	Shirt
	5	Shoe

With a maximum of 100 points, a score greater than 90 is regarded as excellent, between 75 and 89 as good, between 60 and 74 as fair, and less than 60 as poor.[12]

TABLE 3. Radin Score[13]

Score	Description
Good	< 10° of loss of motion in any direction and no symptoms
Fair	Up to 30° of loss of motion in any direction, minor problems, or both
Poor	> 30° of loss of motion in any direction, major problems, or both

or quantify displacement. Broberg and Morrey[8] modified Mason's classification, quantifying displacement as 2 mm or greater articular step-off or gap, and indicating that fracture fragments representing less than 30% of the articular surface should not be considered type II. It is generally agreed that type I fractures can be treated nonoperatively with early mobilization.[2] The best treatment of type II fractures not associated with other fractures or ligament injuries (so-called *isolated fractures*) is still debated. Some authors favor nonoperative treatment; others favor open reduction internal fixation.[9] The aim of this systematic review was to combine the results of relevant studies on treatment of displaced partial articular radial head fractures without associated elbow dislocation or other elbow fractures, to focus the debate between operative and nonoperative treatment.

MATERIALS AND METHODS

We used the criteria of the Quality of Reporting of Meta-analyses statement for reports of meta-analyses of randomized, controlled trials.[10] Although these criteria are designed to guide systematic reviews of randomized, controlled trials, in this review, we used them to guide the review for other study types.

Search strategy and data sources

We systematically screened the electronic databases, PubMed, EMBASE, and the Cochrane Controlled Trials Register from 1980 until September 2011. As main keywords, we used the MeSH terms "radial head" and "fracture OR trauma." For all articles selected, we searched the reference lists for additional articles.

Study selection

Two reviewers independently assessed all references, abstracts, and articles for inclusion. Agreement was needed for inclusion of a study. In case of disagreement, the opinion of a third investigator was decisive. To prevent investigator bias, reviewers scoring manuscripts were blinded to author and institute. We included studies when there was a proper description of

TABLE 4. Demographic Data and Results of All Patients of Included Retrospective, Level IV Studies

Treatment	Author	Year	Patients in Study (n)	Men/ Women	Mean Age (y) (Range)	Mean Follow-up (y) (Range)	Excluded Patients (n)
Nonoperative	Khalfayan et al[15]	1992	26	17/9	39 (21–77)	1.5 (0.5–7.8)	0
	Miller et al[16]	1981	39		— (14–77)	10 (1–22)	5
	Radin and Riseborough[13]	1966	88	39/49	47 (24–75)	> 2	74
	Duckworth et al[17]	2011	201	94/107	44 (16–83)	1	121
	Combined results						
Open reduction internal fixation	Ertürer et al[18]	2010	21	14/7	36 (25–58)	2.6 (0.9–6.7)	0
	Esser[19]	1995	20		29 (14–57)	7 (1–14)	10
	Givissis[20]	2008	19	12/7	37 (19–78)	6.7 (1.9–11.3)	10
	Khalfayan[15]	1992	26	17/9	39 (21–77)	1.5 (0.5–7.8)	16
	Lindenhovius[9]	2008	16	9/7	39 (17–54)	1.8 (1.2–2.5)	0
	Michels[21]	2007	14	5/9	38 (19–57)	5.5 (1–11.3)	0
	Duckworth[17]	2011	201	94/107	44 (16–83)	1	121
	Combined results						

Subsequent operative treatment, number of patients who underwent surgery after failed nonoperative treatment or re-surgery after primary surgery; arthrosis, number of patients with arthrosis of the elbow after follow-up; UH, ulnohumeral arthrosis; NS, type of arthrosis not specified.

The number of patients of each study excluded for this review is provided. Results are given as the number of patients with successful treatment compared with the total number of patients treated. Success rates are defined as excellent or good results, according to the Broberg and Morrey and Mayo Elbow Performance Score, or good according to the Radin score. Combined results of nonoperative and surgical treatment are provided. Range of motion is provided as mean flexion-extension/pronation-supination unless otherwise specified.

*$P = .01$.

†Range of motion is provided as mean range of flexion and extension/pronation and supination.

the treatment for radial head fractures (implant type, surgical technique, rehabilitation methods, immobilization, and follow-up protocol) and a well-defined outcome: the Broberg and Morrey score[11] (Table 1), Mayo Elbow Performance Score[12] (Table 2), or Radin score[12] (Table 3). Other inclusion criteria were a fracture classification according to the Mason classification or 1 of its modifications and separately described results for each Mason type. Exclusion criteria were duration of follow-up of less than 6 months, an improperly described therapy or a combination of therapies, and skeletal immaturity. We excluded articles in languages other than English. We also excluded results of radial head fractures with associated elbow fractures or elbow dislocation. In addition, we assessed the type of study design, participants' characteristics, and the details of intervention.

Validity assessment and data extraction

We considered trials to be valid when they satisfied the inclusion and exclusion criteria and contained sufficient data for further analysis. The initial database search identified 717 potential reports. Of these reports, 657 could be excluded on the title alone, and 31 were excluded after analysis of the abstract. We excluded 20 studies after analysis of the full text. A total of 9 studies could be included. A search of the reference list of the included studies retrieved no additional reports. We identified no duplicate publications.

Two separate reviewers extracted as much patient data as possible for each Mason group. In case of disagreement, the opinion of a third investigator was decisive. Adaptations of the Mason classification that were used, such as the Hotchkiss adaptation[6] and the Broberg and Morrey[8] adaptation, were reduced to the original Mason classification. Thus, fractures classified as Mason-Hotchkiss type II and Mason-Broberg and Morrey type II fractures were regarded as Mason type II fractures. We defined successful treatment as an excellent or good result at follow-up according to the Broberg and Morrey score and Mayo Elbow Performance Score, or good according to the Radin score.[13] Other parameters that we sought were range of motion, subsequent surgery after initial treatment, and arthrosis of the elbow joint. If we excluded some of the patients in a single study and we were not able to provide separate data of the (mean) age, sex, and follow-up

TABLE 4. Continued

Success Rates			ROM					
Radin	Broberg-Morrey	Mayo Elbow Performance Score	Flexion	Extension	Pronation	Supination	Subsequent Operative Treatment	Arthrosis
	7/16		129	−6	76	78	2	16 (NS)
26/34				59% full range of motion			1	
6/14								
		75/78		139†		179†	0	
	114/142 (80.3%)*							
	19/21		132	−2	73	72	0	1 (NS)
	10/10	—	142	−1	88	87	0	—
		8/9	130	−11	81	66	1	—
	10/10	—	136	−16	78	78	1	1 (NS)
	13/16			129†		166†	2	2 (UH)
	14/14		142	−3			0	3 (NS)
		2/2					0	
	76/82 (92.7%)*							

period for the included patients, the means of the total patient population of the study were provided.

Study characteristics

Two authors independently graded the level of evidence for each included article according to the system used by the *Journal of Hand Surgery,* American edition.[14] In case of disagreement, the opinion of a third investigator was decisive. All included studies were retrospective case series (level IV).

Statistics

We used the chi-square test (or Fisher exact test) to compare the rate of success between treatment groups after a biostatistician was consulted. A P value below .05 was considered significant. We did not pool or compare other data from the included studies. These data (for example, patients' characteristics, development of arthrosis, range of motion, pain, and mechanical blockage) were missing in some of the included studies or presented in different ways.

RESULTS

Nine retrospective case series (level IV) could be included and described 444 patients; of these, we extracted data from 224 patients who met the inclusion criteria. Nonoperative treatment consisted of immediate active mobilization or cast immobilization for 1 to 3 weeks. Four studies reported on nonoperative treatment of type II radial head fractures. Success was documented in 114 of 142 patients (80%) pooled from the studies (42% to 96% success in individual studies). Subsequent operative treatment after failed nonoperative treatment was reported in 3 patients (2%). The results of open reduction internal fixation were described in 7 studies, including 82 patients. Success was documented in 76 of 82 patients (93%) (81% to 100% success in individual studies). Revision surgery was reported in 4 patients (5%). Presence of complications, such as arthrosis and subsequent operative treatment, were not reported in any of the included studies. The rate of success was significantly higher in the open reduction internal fixation group compared with the nonoperative group ($P = .01$). Table 4 lists detailed results of all studies.

DISCUSSION

We cannot draw firm conclusions from this systematic review because we included retrospective studies with a

low level of evidence, small patient numbers, and a large heterogeneity in study design and results. Important data regarding development of arthrosis, range of motion, pain, and mechanical blockage retrieved from the included studies are missing or presented in different ways. Combined with the wide variety in classification systems, treatments, and outcome measures, this makes it difficult to compare results among studies. The mean follow-up period of most of the included studies is short, so success rates may decline with time.

The mean range of motion decreased in all directions after operative or nonoperative treatment (Table 4). However, a full range of motion is not essential for performance of all the activities of daily living. The functional arc of flexion and extension used in performing most daily activities is 30° to 130°, and 50° of pronation and supination are required to perform 90% of daily activities.[22] If, for example, surgical treatment leads to a better range of motion, it might well be that this increase has no functional consequences. On the other hand, young and active patients with high-demand elbow function may experience a mild functional deficit as troublesome. In these patients, this functional improvement after surgical treatment can be worthwhile. The follow-up period of most of the included studies was too short to determine whether there was a difference in degenerative changes of the elbow joint for both treatments. Although the success rate of operative treatment is significantly higher than nonoperative treatment (93% vs 80%), there were too many variables, such as period of immobilization and follow-up period, within and between treatment groups to claim that operative treatment provides the best results.

To obtain comparable results from individual studies for this systematic review, we reduced the Mason-Broberg and Mason-Hotchkiss adaptations of the Mason classification to the original Mason classification. However, some Broberg and Morrey or Hotchkiss type I fractures would be considered a type II fracture in the Mason classification. We were not able to review the radiographs from the included studies for the degree of displacement and percentage of radial head involvement. We also had to make assumptions with regard to the sex, age, and follow-up of the Mason type II fractures, because many articles did not provide separate data. In these cases, we provided the data of the entire study cohort, which also included other Mason type fractures and fractures with associated injuries.

Presence of associated fractures or ligament injuries was not well described and has not clearly been distinguished in the included studies. Rineer et al[23] described a strong correlation between the likelihood of associated injury and the absence of cortical contact of the radial head fragments (unstable radial head fractures). Isolated, displaced fractures are not only difficult to define and diagnose; they are relatively uncommon and may not be reliably identified.[24] The relative infrequency of these issues and inconsistency in what various observers feel merits the diagnosis of displacement make these fractures difficult to study and the reported data difficult to interpret.[24–26]

Studies describing the results of new implant types for open reduction internal fixation or new surgical techniques should be interpreted in light of the fact that these studies could be considered introductory, promotional, and subject to bias. These studies also have the tendency for initially positive results to become less positive or even neutral or reversed as additional experiments are done, owing to the result of regression to the mean, sampling error, and publication bias, among other factors.[27] There is room for debate about the indications for surgery and the relative risks and benefits compared with nonoperative treatment of Mason type II radial head fractures. Herbertsson et al[28] and Akesson et al[3] reported good long-term results with nonoperative treatment of Mason type II radial head fractures after a mean follow-up of 19 years. We excluded both studies from this review because of the absence of 1 of the selected outcome measures or inclusion of patients with associated fractures but without providing separate results.

To focus the debate between operative and nonoperative treatment of displaced but stable, isolated partial articular fractures of the radial head, we need prospective, randomized, controlled trials comparing the 2 treatment strategies. To ensure that the results of these trials can be generalized to the average patient and the average surgeon, we need clear definitions as well as reliable and accurate methods for diagnosing and quantifying displacement and associated injuries. Better-designed retrospective comparative studies with long-term follow-up of operative and nonoperative treatment for well-defined fracture types could also be useful. Rather than physician-based overall scoring systems, we should study final forearm motion and arm-specific disability. Complications such as persistent pain and failed initial treatment with subsequent (revision) surgery should be adequately reported.

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