Radial head fracture: a potentially complex injury

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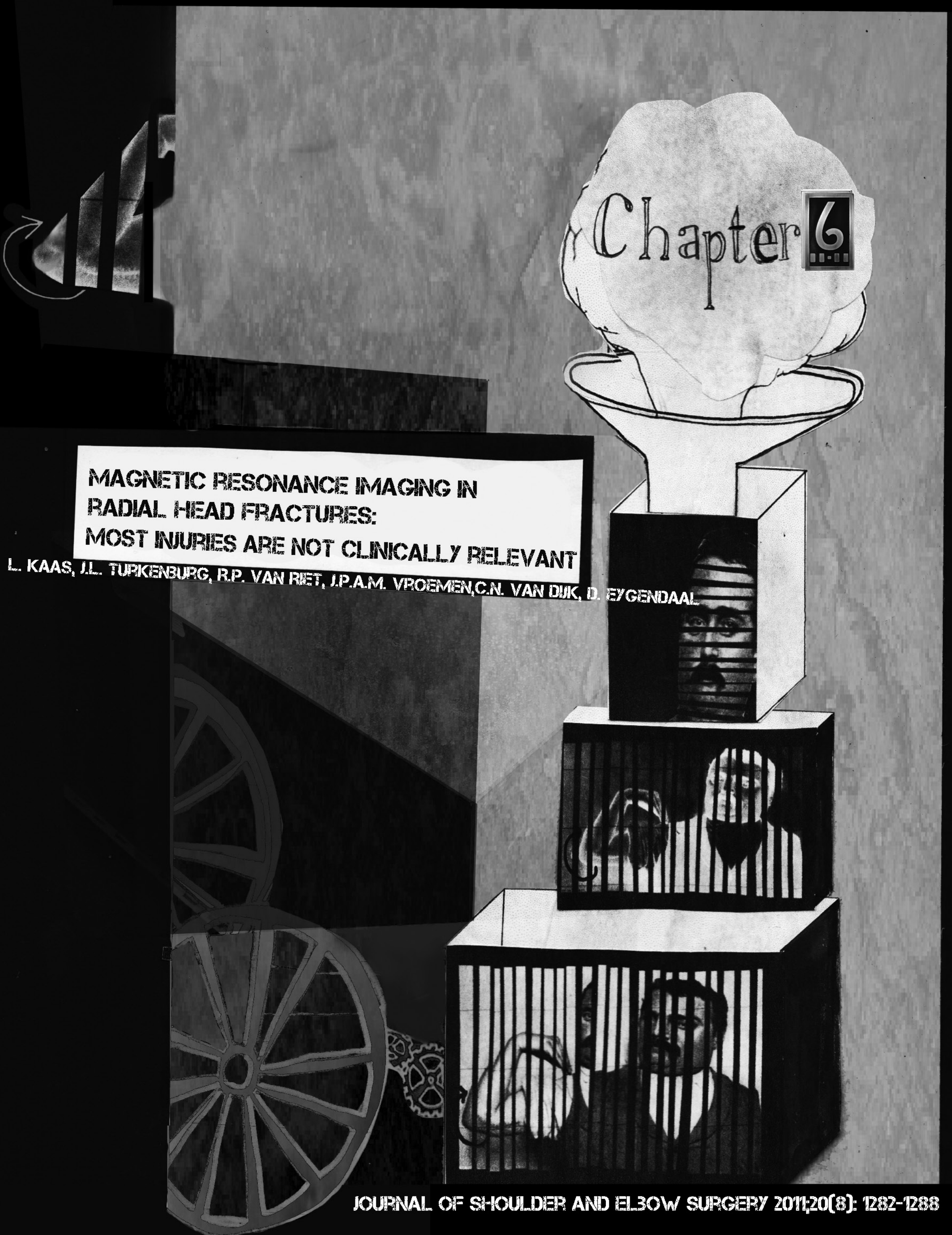

Chapter 6

MAGNETIC RESONANCE IMAGING IN RADIAL HEAD FRACTURES: MOST INJURIES ARE NOT CLINICALLY RELEVANT

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ABSTRACT

Background: Recent studies report that magnetic resonance imaging (MRI) shows a high incidence of associated injuries in patients with a radial head fracture. This retrospective study describes the clinical relevance of these injuries. *Methods:* Forty patients with 42 radial head fractures underwent a MRI scan after a mean of 7.0 days after trauma and were reviewed after a mean of 13.3 months. *Results:* MRI showed 24 of 42 elbows had a lateral collateral (LCL) lesion, 1 had a medial collateral ligament (MCL) and LCL lesion, 16 had an injury of the capitellum, 1 had a coronoid fracture and 2 had loose osteochondral fragments. Clinical evaluation after a mean of 13.3 months showed that 3 elbows had clinical MCL or LCL laxity, of which 2 elbows had no ligamentous injuries diagnosed with MRI. One elbow with a loose osteochondral fragment showed infrequent elbow locking. The mean Mayo Elbow Performance Scale was 97.5 (range: 80-100) after a mean of 13.3 months after trauma, with no significant difference between patients with and without associated injuries ($p = 0.8$). *Conclusion:* Most injuries found with MRI in patients with radial head fractures are not symptomatic or of clinical importance in short term follow-up.
Keywords: radial head fracture, elbow, trauma, magnetic resonance imaging, associated injuries. *Level of evidence:* IV.

INTRODUCTION

Radial head fractures are common, accounting for approximately one third of all fractures of the elbow and for 1.7 to 5.4% of all fractures in adults.[1, 2] They usually are categorized according to the Mason-Hotchkiss classification in to type I to III: a type I indicates a fracture that is ≤ 2 mm displaced, a type II fracture is > 2 mm displaced, a type III fracture is a comminuted fracture of the entire radial head.[3] Radial head fractures are frequently accompanied with associated osseous, chondral and/or ligamentous injuries of the ipsilateral upper extremity.[4-6] Ligamentous and chondral injuries remain commonly undetected by conventional radiographs, but may have consequences for treatment.[2, 7-9] Recent studies using magnetic resonance imaging (MRI) show a 76-92% incidence of associated injuries in patients with a radial head fracture.[4, 10] In a retrospective study of 333 patients with a radial head fracture, clinically relevant associated fractures or soft-tissue injuries, or both, were diagnosed in 39% of the patients.[5] Early diagnosis of these injuries using MRI might provide greater understanding of injuries of the patient with a radial head fracture, and optimise (surgical) treatment and provide the patient with a better estimate of their prognosis. The clinical relevance of concomitant injuries found with MRI is unclear. This retrospective, observational study aims to describe the clinical relevance of associated injuries diagnosed with MRI in patients with a radial head fracture.

PATIENTS AND METHODS

A retrospective evaluation was conducted of 44 consecutive patients who presented with 46 radial head fractures in our emergency department (ED) within 48 hours after trauma. Radial head fractures were classified using the Mason-Hotchkiss classification.[3] Apart from conventional radiographs, these patients underwent a standard MRI scan to evaluate associated injuries of the affected elbow. The MRI scan was made at a mean of 7.0 (range: 1-16) days after injury and was performed with a 1.5 Tesla scanner (Signa, General Electric Medical Systems, Milwaukee, WI, USA) with a dedicated small flex coil.

The dominant arm was affected in 21 of 42 elbows. 17 elbows had a Mason type I fracture on plain radiographs, 19 had a type II fracture and 6 had a type III fracture. 2 elbows, both with a type III fracture, had a posterolateral elbow dislocation. Treatment was initiated by the (orthopaedic) surgeon on call. MRI results were available for treating physician. 1 patient with a Mason type III fracture with posterolateral elbow dislocation underwent surgical treatment: an open reposition and internal fixation of the comminuted fracture of the radial head and a refixation of the LCL. All other patients were treated conservatively.

According to a standard protocol for follow-up of patients with a radial head fracture, 38 patients (86%) with 40 radial head fractures, who were a mean age of 46.1 years (range:

		Points
Pain	None	45
	Mild	30
	Moderate	15
	Severe	0
Motion arc	> 100 degrees	20
	50-100 degrees	15
	< 50 degrees	5
Stability	Stable	10
	Moderate instability	5
	Gross instability	0
Daily function	Comb hair	5
	Feed self	5
	Hygiene	5
	Shirt	5
	Shoe	5
Total		Maximum 100

Table I: The Mayo Elbow Performance Score. A score > 90 is regarded as excellent, between 75-89 as good, between 60-74 as fair and < 60 is graded as poor.[11]

21-75 years), were reviewed after at least 12 months and were evaluated at a mean of 3.5 (range: 3-5) months and 13.3 (range: 12-19) months after trauma. Two patients did not attend the evaluation at 12 months, but were willing to answer questions by phone. These results were included in this study. Four patients (11%), all with a Mason type II fracture, were lost to follow-up.

Presence of crepitus or hydrops, range of motion (flexion/extension and pronation/supination using a standard goniometer), carrying angle, and stability of both elbows were assessed. Stability was classified into 3 types: type I: painful on palpation and stress but stable, type II: mild laxity, type III: gross laxity. Furthermore, the patients were questioned on the presence of wrist pain, the use of analgesics and resumption of work. Elbow function was scored using the Mayo Elbow Performance Score (MEPS) (table I).[11] Radiographs of the elbow and wrist were obtained on indication.

The MRI scans and radiographs were evaluated for associated pathology by one of two experienced radiologists. Ligamentous injuries of the lateral (LCL) and medial collateral ligament (MCL) were divided into four subtypes: distortion, partial rupture, complete rupture and avulsion fracture. The Regan and Morrey classification was used to classify coronoid fractures.[12] A type I fracture is an avulsion fracture, a type II fracture consists of <50% of the coronoid height and a type III fracture of >50%. In case of doubt when analysing the MRI's the final decision was made by a single musculoskeletal radiologist.

Type of associated injury		Mason (N)			
		I (17)	II (19)	III (6)	Total (42)
LCL	Distortion	0	4	0	4
	Partial rupture	7	3	2	12
	Complete rupture	1	5	2	8
	Avulsion fracture	0	0	1	1
	Total	8	12	5 (%)	25
MCL	Complete rupture	0	0	1	1
Capitellum	Bone bruise	6	1	1	8
	Chondral damage	2	3	0	5
	Fracture	1	1	1	3
	Total	9	5	2	16
Coronoid fracture		0	0	1	1
Loose body		0	2	0	2
Total		17	19	9	45

Table II: MRI findings of the 42 elbows. N = number of patients per Mason group.

The quality of the MRI's was excellent in all except 2 elbows, where evaluation of the images was difficult because of motion artefacts.

Ten other patients which presented at the ED in the same period did not receive an MRI scan as the timing of it would adversely delay the treatment of the injury. Associated injuries in these were assessed during surgery. In these patients, 5 had a Mason type II fracture (including 1 patient with a Monteggia lesion) and 5 patients had a Mason type III fracture, including 1 patient with an olecranon fracture and posterior dislocation, 1 patient with an olecranon fracture and a type III coronoid fracture after a posterior dislocation and 1 patient with a coronoid fracture and posterior dislocation). This imaging delay was caused by several factors, such as inability to perform a MRI scan within 10 days after trauma or severity of the injury, in which delay of more than 1 day by performing the MRI before surgical treatment was unacceptable. These patients were not included in this study.

STATISTICAL METHODS

Because of a skewed distribution, The Mann-Whitney test was used to compare functional results between patient groups with or without associated injuries. The Chi-square test was used to compare dichotomous variables between groups. SPSS 16.0 software (SPSS, Chicago, Il) was used for statistical analysis.

Patient characteristics					MRI Results					Clinical results					
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	1	+	29	1	-/-	-	-	-	-	13	0/0/0/0	-/-	-	100	100
2*	1	--	28	1	-/1	3	-	-	-	14	5/0/0/0	-/-	-	100	100
3	0	+	44	1	-/-	1	-	-	-	12	0/0/0/0	-/-	-	100	100
4	1	-	51	1	-/1	-	-	-	-	13	10/10/0/0	-/-	-	100	100
5	0	-	45	1	-/-	-	-	-	-	15	0/0/0/0	-/-	-	85	100
6	0	-	21	1	-/-	1	-	-	-	19				85	100[‡]
7	1	+	61	1	-/2	-	-	-	-	12	0/0/0/0	-/-	-	100	100
8	0	+	45	1	-/1	-	-	-	-	13	0/20/0/0	-/-	C	100	85
9	0	+	26	1	-/-	1	-	-	-	18	0/15/0/	-/-	-	-	100
10	0	-	56	1	-/1	-	-	-	-	15	0/0/0/0	-/2	-	65	95
11	1	-	55	1	-/1	2	-	-	-	12	0/0/0/0	-/-	-	100	100
12	0	+	42	1	-/-	-	-	-	-	14	0/0/0/0	-/-	C,W	85	85
13	0	+	52	1	-/1	2	-	-	-	13	10/0/0/	-/-	-	85	100
14	1	+	29	1	-/1	1	-	-	-	13	0/0/0/0	-/-	S	100	100
15[#]	0	+	44	1	-/-	-	-	-	-	13	15/5/0/10	-/-	C	95	100
16	1	+	20	1	-/-	1	-	-	-	12	0/0/0/10	-/-	-	100	100
17	1	-	60	1	-/-	-	-	-	-	13	0/0/0/0	-/-	-	100	100
18	0	-	48	2	-/-	-	-	-	-	12	0/15/0/0	-/-	-	100	100
19	1	+	35	2	-/2	2	-	-	L	13	5/0/0/0	-/-	L	85	85
20	0	-	45	2	-/2	-	-	-	-	12	10/40/0/0	-/-	C	85	85
21	0	+	53	2	-/-	2	-	-	-	13	0/10/0/0	-/-	-	100	100
22	1	+	53	2	-/-	2	-	-	-	12	0/0/0/0	-/-	-	100	100
23	0	+	75	2	-/2	3	-	-	-	12	0/20/0/0	-/-	-	100	100
24	1	-	37	2	-/0	-	-	-	-	19	10/5/0/0	-/-	-	85	100
25	1	+	22	2	-/0	-	-	-	-	12	0/0/0/0	-/-	-	100	100
26	0	-	60	2	-/0	-	-	-	-	12	0/0/0/0	-/-	C	100	100
27	0	-	61	2	-/1	1	-	-	-	13	5/10/0/0	-/-	-	100	100
28[#]	0	-	44	2	-/2	-	-	-	L	13	15/5/0/10	-/-	C	95	100
29	0	-	25	2	-/1	-	-	-	-	12	10/10/0/0	-/-	C	65	85
30	0	+	36	2	-/-	-	-	-	-	13	0/0/0/0	-/-	-	100	100
31	0	-	38	2	-/-	-	-	-	-	13	5/0/0/0	-/-	C	100	100
32	0	-	69	2	-/0	-	-	-	-	16	0/10/0/0	-/-	C	100	100
33*	1	+	28	2	-/-	-	-	-	-	14	5/0/0/0	-/-	-	100	100
34	1	+	59	2	-/1	-	-	-	-	13	0/10/5/0	-/-	-	85	100
35	1	+	54	2	-/2	1	-	-	-	12	5/30/0/0	-/-	C	85	100
36	0	-	34	2	-/-	-	-	-	-	13	0/0/0/0	-/-	-	65	100
37	0	+	53	3	-/3	-	-	-	-	15	0/15/0/10	-/-	C	100	100

38	0	+	68	3	2/2	-	-	1	-	13				95	100‡
39	1	+	45	3	-/1	1	-	-	M	13	15/10/0/0	2/-	C,W	80	80
40	0	+	51	3	-/1	-	-	1	-	12	0/5/0/0	2/-	C	100	95
41	0	-	64	3	x/x	-	1	-	M	12	10/10/0/10	-/-	-	85	100
42	0	-	52	3	-/2	3	-	-	-	12	25/10/0/0	-/-	-	95	100

Table III: Patients characteristics, MRI findings and clinical results after the mean follow-up of 13.3 months, summarised per patient.

Legends to table 3:
A = Number of subject
B = Sex: 0 = female, 1 = male
C = Dominant side
D = Age (years)
E = Mason-Hotchkiss type
F = MCL/LCL lesion: 0 = contusion, 1 = partial, 2 = complete, 3 = avulsion fracture
G = Capitellum: 1 = bone oedema, 2 = chondral damage, 3 = fracture
H = Coronoid fracture: 1 = type I, 2 = type II and 3 = type III
I = Dislocation of the elbow joint
J = Other: M = Movement artefacts, L = loose body
K= Follow-up period in months
L = Flexion/extension/pronation/supination deficit
M = Grade of instability: MCL/LCL
N = Complaints: E = elbow pain, C = Crepitus, L = Locking, W= Wrist pain, S = Snapping
O = MEPS after 3.5 months
P = MEPS after 13.3 months, ‡ = MEPS obtained by phone
x = No reliable observation because of movement artefact.
* and # = bilateral fracture of the radial head in two patients.

RESULTS

MRI scanning results

With MRI, 2 elbows with a presumed Mason type II fracture, were reclassified as a Mason type I fracture. In 32 of the 42 elbows (76%), 45 concomitant injuries were diagnosed with MRI, and 12 patients with a type I fracture, 14 with a type II fracture and 6 with a type III fracture appeared to have associated injuries. LCL injuries were diagnosed in 25 patients. Injury to the LCL occurred in 47% of the Mason type I fractures compared with 63% and 83% in type II and III fractures; however, this increase in incidence was not statistically significant (p=0.10) A complete MCL rupture was seen in 1 patient, capitellar injuries occurred in 16, osteochondral loose bodies were found in 2, and a Regan and Morrey type I coronoid fracture was seen in 1. Results are summarized in table II. MRI findings per patient are presented in table III.

Clinical findings

At the follow-up period of 13.3 months, a flexion deficit occurred in 19 of 42 elbows(45%) and was a mean of 3.9° (range: 0-25). An extension deficit occurred in 15 elbows (43%) and was a mean of 6.4° (range: 0-40). Seven (16%) elbows had supination deficit and the

Type of associated symptoms		Number of patients	
	Grade	3.5 months	13.3 months
LCL instability	I	4	-
	II	-	1
	II	-	-
MCL instability	I	1	-
	II	2	2
	III	-	-
Crepitus		11	13
Locking		0	1
Wrist pain		6	2

Table IV: Clinical findings of the patients after 3.5 and 13.3 months.

mean supination deficit was 1.3° (range: 0-10). Pronation was equal to the unaffected side in all patients.

A non-painful crepitus was present in 13 patients, of which 1 patient had chondral damage of the capitellum with MRI. One of the 2 patients with a loose body on MRI had an infrequent non-painful elbow locking. One other patient experienced non-painful elbow snapping. These symptoms were mild and neither patient needed surgery. Two patients presented with a pain at the wrist, but further evaluation by an upper extremity specialist did not reveal any signs of longitudinal instability. One patient with a type I fracture occasionally used analgesics for elbow pain. All patients resumed their original professions except 1 patient who had a type I fracture without associated injuries. The mean MEPS was 92.8 (range: 65-100) after 3.5 months and 97.5 (range: 80-100) after 13.3 months: 6 elbows scored a good result after 13.3 months, and 36 scored an excellent result. There was no statistically significant difference in MEPS between patients with and without associated injuries ($p = 0.8$).

At 3.5 months, a grade I varus laxity was present in 4 elbows (2 Mason type I and 2 Mason type II fractures), which were asymptomatic and stable at the evaluation after 13.3. months. In 2 of these patients an LCL injury was diagnosed with MRI. A grade II varus laxity was diagnosed in 1 elbow with a Mason type I fracture at 13.3 months. This patient had no laxity at 3.5 months and had a partial LCL lesion with MRI, but did not experience pain or instability complaints of the injured elbow at follow-up. The MRI-documented LCL lesion of the patient with type III fracture who underwent surgical treatment was confirmed and reconstructed during surgery.

A grade I valgus laxity was diagnosed in 1 elbow with a Mason type II fracture and a grade II valgus laxity in 2 elbows with a Mason type III fracture at the follow-up of 3.5 months. At 13.3 months 2 patients Mason type III fracture had a grade II valgus laxity, of which one was symptomatic with heavy lifting. This patient did not have surgical MCL reconstruction as the complaints were only incidental. The other patient had no objective laxity at 3.5 months of follow-up. In these 2 patients the MCL was diagnosed as intact with MRI. The patient with the complete MCL rupture on MRI completed a telephone interview after 13 months. Stability could not be objectively tested, but the patient did not experience subjective elbow instability. Clinical results are summarized in table IV and clinical results per patients are presented in table III.

Medical records were reviewed of the 4 patients lost to follow-up, all with Mason type II fractures: one patient did not appear on the out-patient clinic after the primary visit to the ED, another patient was seen on the out-patient clinic 10 days after trauma and active mobilisation was advised. The third patient had an extension deficit of 10° with normal pro- and supination 3 weeks after trauma. The fourth patient had an extension deficit of 25° at 4 months after trauma and was advised physiotherapy en re-evaluation if no functional improvement was achieved. This patient did not return for re-evaluation. Stability was not tested in all these patients.

DISCUSSION

This study shows that concomitant injuries of the elbow with a radial head fracture are common, but not always symptomatic. MRI led to the diagnosis of associated injuries in 32 of 42. Only 2 of 45 (4.4%) MRI findings were symptomatic at a mean follow-up of 13.3 months. MRI was used to diagnose 22 partial or complete ruptures of one of the collateral ligaments of the elbow. After 13.3 months follow-up, laxity of the elbow was seen in only 1 of these cases. This patient did not report subjective elbow instability; however, this was a low-demand sedentary patient.

In the patients with ligamentous injury without elbow laxity, sufficient clinical elbow stability may be provided by the remaining part of the injured ligament, the intact osseous constraint, and the secondary stabilizers, as the common extensor tendon and the common flexor-pronator tendon.[13] Another explanation may be the potential self-healing power of the collateral ligaments, as has been described for the ankle and knee[14, 15], or that a pseudo-instability existed as result of an insufficient radial head. A fourth explanation is that the specificity and sensitivity of the MR images could be low, as in this population 2 elbows had MCL laxity at 13.3 months follow-up, without a lesion with MRI. MRI has a reported sensitivity of 57-100% and a specificity of 100% in complete MCL rupture.[16, 17] MRI has a sensitivity of only 57% and a specificity of 100% in detecting partial ruptures of the MCL.[17] Potter et al. have shown that MRI is highly sensitive and specific for LCL pathology in patients with posterolateral instability.[18] MRI-arthrography (MRA) improves the sensitivity and specificity of partial ligament rupture and MRA is preferred for diagnosis of loose bodies.[19, 20] If joint effusion is present, as is the case in our patients who were scanned in the acute phase after radial head fracture, MRI without contrast is preferred.[21] We did not investigate inter- and intra-observer reliability, as Itamura et al. found a coefficient variation less than 5% for intra-observer reliability and the F-test between two observers was not statistically significant for each MRI set.[4]

Several studies in the past 10 years have shown a high incidence of associated injuries with radial head fractures. MRI has found associated injuries ranging from ligamentous injuries to capitellar bone bruise are found in 76 to 96% of the patients with a radial head fracture.[4, 10] In a retrospective study of 333 patients with a radial head fracture by van Riet et al., clinically relevant associated injuries of the ipsilateral upper extremity were diagnosed in 39%.[5] The Mayo classification of radial head fractures was based on this study, and accounts for these clinically relevant injuries, by addition of a suffix to the original Mason classification.[22] It was not used in the current study, as all associated injuries were detected by MRI and it was our goal to examine the clinical relevance of these lesions. Our study is the first study that attempts to correlate the results of MRI in patients with a radial head fracture with clinical findings. It also provides a possible explanation of the difference between the high incidence of concomitant injuries found with MRI[4, 10] and the lower incidence of clinically relevant associated injuries on physical examination found by van Riet et al.[5] Hausmann et al.[23] found partial ruptures of the interosseous membrane using MRI of the forearm in 9 of 14 patients with a Mason type I radial head fracture, of whom 7 were symptomatic. This suggests that lesions of the interosseous membrane is more frequent than expected. In this study 2 of 42 elbows had wrist pain after 13.3 months of follow-up, although no signs of an ALRUD were found. The study by Hausmann could explain the wrist pain of the patients in our study, although we did not visualize the interossous membrane.

The incidence of LCL injuries noted by MRI suggests a trend of increasing injury in radial head fractures of increased severity (Mason type II and III), but due to small patients numbers, this increase is not statistically significant. However, van Riet et al.[5] already showed a significant increased likelihood of associated injuries as the radial head fracture severity increases. Johansson found ligament or capsular disruption by arthrography in 4% of type I, 21% of type II and 85% of type III fractures.[24]

An important limitation of this study is that 10 cases underwent surgery without having a MRI, as the MRI would adversely delay their treatment. The incidence of associated injuries in these patients can be expected to be higher owing to the type of their lesions.[5] This deficiency has the potential to skew results, because these excluded patients also had radial head fractures with concomitant elbow dislocation or ulnar fracture. In these severe injuries, one might suspect a higher incidence of associated pathology and that such pathology might be clinically more relevant. Diagnosis and understanding of the concomitant injuries in these patients is of great importance for an adequate treatment.[2, 25] A pre-operative MRI might help with pre-operative planning and could be of benefit for this group. However, assessment during surgery is a good alternative, for example, stability testing under fluoroscopy, and evaluation of the cartilage of the capitellum during ORIF of the radial head. Mason type I and (borderline) type II radial head fractures were mostly included in this study. Most patients with these fracture types usually do well with conservative treatment, as was noted in this study. The MRI findings in these patients did not nor would have influenced treatment. Four patients, all with a Mason type II fracture, were lost to follow-up. This is a considerable number and may have influenced the results of this study; however, a review these patients' medical records indicated that good functional results are likely.

An advantage of this study is the relative large number of patients compared with other clinical studies of radial head fractures. However, the population in this study is too diverse and too small to draw firm conclusions on the clinical relevance of associated injuries in subgroups. Follow-up was relatively too short to assess the precise clinical consequences of the osteochondral lesions, as these patients might be more prone to develop osteoarthritis in later life compared to those without osteochondral lesions.

CONCLUSIONS

A high number of associated injuries is detected in patients with radial head fractures. Associated injuries were diagnosed with MRI in 32 of 42 elbow with a Mason type I to III radial head fracture. However, the vast majority of these findings were not were symptomatic after 13.3 months of follow-up.

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