Radial head fracture: a potentially complex injury
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Chapter 11

DISCUSSION AND SUMMARY

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Introduction
Radial head fractures are common and account for up to one third of all elbow fractures, and were probably first described by Paul of Aegina (AD: 625-690). In 1935, Jones already stated that: “The fracture of the head of the radius is a serious injury, and whilst the prognosis is good for recovery of a useful elbow, rarely it is a normal elbow.” Although knowledge of radial head fractures has increased over the past few decades, many aspects of this common fracture are still not clear.

This thesis contains four parts, in each of which an issue relating to radial head fractures was discussed. In part I elbow anatomy, etiology, diagnosis and treatment of radial head fractures were addressed. The epidemiology of radial head fractures and their associated osseous injuries, as well as the relationship between radial head fractures and osteoporosis, were discussed in part II. Part III focused on the incidence and clinical relevance of osseous, cartilaginous, and ligamentous, associated injuries in elbows with a radial head fracture. Injury to the medial collateral ligament (MCL) was discussed in a broader spectrum and in more detail. In part IV a systematic review was performed on the treatment of stable Mason type II fractures without associated fractures or elbow dislocation. This part also described the short-term results of the cemented and press-fit radial head prostheses in patients with post-traumatic disorders of the elbow. The inter- and intra-observer agreement of the Mason-Hotchkiss classification was also evaluated.

Part I: General introduction and current issues
The radial head is one of the three bones of the elbow joint. Together with the proximal ulna and distal humerus, it forms the ‘articulatio cubiti’ or elbow joint. The radial head is an important bony stabilizer of the elbow joint. Fracture of the radial head occurs as a result of a fall on the outstretched arm with the elbow in slight flexion and pronation. Radial head fractures can be classified according to the Mason classification, or one of its modifications. Clinically relevant associated injuries occur in up to one third of all elbows with a radial head fracture and are of great importance in treating patients with (complex) elbow trauma. On physical examination the radial head is painful on palpation and a heamarthrosis is seen. Elbow range of motion, especially pro- and supination, is decreased because of pain. Ligamentous injury can be suspected in case of pain on palpation and/or ecchymosis of the medial and/or lateral aspects of the elbow. Stability and neurovascular status should be examined and one should look for associated injuries. The diagnosis can be made with lateral and anteroposterior (AP) radiographs of the elbow. To determine the number of fragments and/or dislocation, a CT scan of the elbow can be performed. Minimally displaced (Mason type I) radial head fractures can be treated non-operatively with early mobilization and results are good in 85-95% of the patients. Treatment of displaced fractures (Mason type II) is still subject of debate: non-operative treatment or ORIF. Comminuted fractures of the radial head are treated surgically, either with ORIF
or radial head arthroplasty.\textsuperscript{14} ORIF of comminuted fractures consisting of >3 fragments is associated with high rates of non-union or failure.\textsuperscript{15} Radial head excision can be performed in isolated, un-reconstructable Mason type III fractures and satisfactory results have been described\textsuperscript{16,17}, but are related to complications as instability and wrist pain, especially in patients with a high demand of their elbow function.\textsuperscript{1}

**Part II: Epidemiology of radial head fractures and the relation to osteoporosis**

Few reports on the epidemiology of radial head fractures and their associated osseous injuries are currently available and little is known about the incidence of radial head fractures and their associated injuries in the European population. Recent literature shows an increased mean age of female patients with radial head fractures compared with male patients with radial head fractures.\textsuperscript{10,18} However, data on epidemiology of radial head fractures and specifically in relation to age distribution and male-female ratios of radial head fracture are scarce. In chapter 3 we described the epidemiology of radial head fractures in the Dutch population, especially the age distribution and male-female ratio, and their associated osseous injuries in the Dutch population. We retrospectively reviewed all 328 radial head fractures that were diagnosed in 322 patients over a period of 3 years. The incidence was 2.8 per 10,000 inhabitants per year. The male-female ratio was 2:3. The mean age was 48.0 years (range: 14-88 years, SD, 14.8). The mean age of female patients (52.8 years) was significantly higher than that of male patients (40.5 years) (P < 0.001). As the age increased above 50 years, the number of female patients became significantly higher than the number of male patients (P < 0.001). These epidemiologic findings suggested a possible link between radial head fractures and osteoporosis. Associated osseous injuries, such as scaphoid or olecranon fractures, occurred in 40 patients (12.4%). The treating physician should be aware of associated injuries when treating patients with radial head fractures.

In chapter 4 we further investigated the relationship between radial head fractures and osteoporosis in females ≥50 years of age with a retrospective case-control study. The hypothesis was that females ≥50 years with a radial head fracture have an increased risk of osteoporosis, compared to female patients of the same age without a radial head fracture. Peripheral BMD measurement of patients and controls was performed at the calcaneus using the DXL Calscan. The 35 women ≥50 years of age with a radial head fracture (cases) had an increased risk of osteoporosis compared to the 57 for age matched female controls, with an OR of 3.4, with a P-value of 0.027. Although patient numbers in this study were limited, these results are supported by the age distribution and male-female ratio of radial head fractures (as described in the previous chapter)\textsuperscript{10,19} and osteoporotic changes in the micro-architecture of the radial head in human cadavers.\textsuperscript{20} As radial head fractures occur on average earlier in life compared to other known osteoporotic fractures, for example distal radius or hip fractures\textsuperscript{21}, recognition of radial head fractures as potential osteopo-
rotic fractures can be of great potential importance: offering these patients screening and treatment of osteoporosis might prevent other future osteoporotic fractures. However, prospective studies with larger patient numbers are in need to determine the exact relative risk of osteoporosis in elderly patients with a radial head fracture.

**Part III: Associated injuries of radial head fractures**

Over the past years an increasing awareness of the importance of associated injuries in the treatment of radial head fractures has been reported. In a retrospective study of 333 patients with a radial head fracture by van Riet et al., clinically relevant associated fractures and/or soft-tissue injuries were diagnosed in 39% of the patients. Recent studies using magnetic resonance imaging (MRI) show a high incidence (92%) of associated injuries in patients with a Mason type III radial head fracture. However, the clinical relevance of concomitant injuries found with MRI was unclear. Early diagnosis of these injuries using MRI, combined with knowledge of the clinical relevance of these injuries 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.

To assess the incidence and clinical relevance of these injuries, we performed a MRI scan of the elbow in 46 patients with a radial head fracture in chapter 5. 17 elbows had a Mason type I fracture, 23 had a Mason type II fracture, and 6 elbows had a Mason type III fracture. Associated injuries were found in 35 elbows. 28 elbows had a lateral collateral ligament lesion, 18 had injury of the capitellum. One elbow had a coronoid fracture and 1 elbow had medial collateral ligament injury. 40 of these patients with 42 radial head fractures were evaluated after a mean period of 13.3 months in chapter 6. The mean Mayo Elbow Performance Scale was 97.5 (range: 80-100), with no significant difference between patients with and without associated injuries ($p = 0.8$). 3 elbows had clinical MCL or LCL laxity, of which 2 elbows had no ligamentous injuries diagnosed with MRI. 1 elbow with a loose osteochondral fragment showed infrequent elbow locking. So we can conclude that most injuries found with MRI in patients with radial head fractures are not symptomatic or of clinical importance in short term follow-up. This could explain the difference in high incidence of concomitant injuries found with MRI and the lower incidence of clinically relevant associated injuries on physical examination found by van Riet et al. However, the population in our studies was too diverse and too small to draw firm conclusions on the clinical relevance of associated injuries in subgroups. Follow-up was 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.

In chapter 7 we described the MCL (or UCL) in a broader spectrum, as it can occur as a result of a posterolateral dislocation of the elbow (with a radial head fracture), but also as
the result of chronic attenuation in (throwing) athletes and as an isolated injury. Although MCL injuries are uncommon in daily clinical practice, it is important to recognize this injury in patients with (post-traumatic) medial elbow complaints. As this injury is relatively unknown, we provided an overview of current literature on MCL injury in this chapter. It is important to recognize this injury in patients with (past traumatic) medial elbow pain. Exact numbers or incidence of this injury in athletes or in the general population are unknown. The preferred imaging technique for detection of MCL injuries of the elbow is MRI with arthrography. Treatment of MCL of the elbow injuries is based on the patients’ athletic demands and the degree of MCL injury. Initial non-operative treatment consists of rest, anti-inflammatory measures and physical therapy, with satisfactory results in 42% of the patients. If non-operative treatment fails, surgical MCL reconstruction can be performed, with success rates of 63-95%, depending on the technique used. The current overall quality of evidence on this subject is very low and prospective studies to determine preferable diagnostic technique, best graft fixation techniques and long term results of conservative and surgical treatment are in demand.

In chapter 8 it was our goal to establish the inter- and intra observer agreement of the Mason-Hotchkiss classification and the influence of clinical experience on agreement, as it is of importance in daily decision making when treating patients with a radial head fracture. The inter-observer agreement was substantial and the intra-observer agreement ranged from fair to substantial. We observed that experienced surgeons scored a higher (almost perfect) inter-observer agreement, compared to the lower end of substantial agreement between residents. However, this difference was not statistically significant. The κ-value for intra-observer agreement for surgical or conservative treatment was 0.69, and inter-observer agreement ranged between 0.38 to 0.57.

Part IV: Classification and treatment

In chapter 9 we performed a systematic review on the treatment of Mason type II radial head fractures, without associated fractures or elbow dislocation to inform the current debate on surgical or non-operative treatment. Of the 149 relevant studies found, only 9 retrospective case series met the inclusion criteria, describing 224 patients. Non-operative treatment was successful in average of 80% (114 of 142) patients (range 43 to 96% in various studies). Open reduction and internal fixation (ORIF) was successful in 93% (76 of 82) patients (range 81 to 100%). Although surgical treatment showed significant better outcome (P = 0.01), strong conclusions cannot be drawn from the currently available literature as the level of evidence is weak and the reports on surgical treatment were usually meant to describe or promote a new surgical technique. Retrospective studies not included in this review reported good long term results with non-operative treatment of Mason type II fractures after a mean follow-up of 19 years. Prospective, randomized clinical trials are needed to determine which treatment provides the best results for these treatments.
stable Mason type II fractures. If an adequate treatment strategy based on prospective studies can be developed, a new treatment-based classification system for radial head fractures could be developed.

Un-reconstructable, multi-fragment radial head fractures can be treated with radial head arthroplasty. Various implants are currently available and can be divided in two types: monoblock and bipolar implants. In chapter 10 we discussed the short-term results of the cemented and press-fit bipolar Judet implant, in a retrospective review of 33 patients with post-traumatic injuries of the elbow. 19 patients scored excellent, 10 scored good, 1 fair and 3 poor on the Mayo Elbow Performance Index, with a median of 100 (range: 55-100). The median Elbow Function Assessment score was 94 (SD: range: 60-100). The median functional range of motion was 130° (range: 80°-145°). Median supination and pronation were 70°. These results are similar to those reported in the literature. However, a good comparison is difficult, as the included patient characteristics, like type of injury, associated injuries and revision surgery highly vary between studies. Although short-term results of both implant types were similar, 11 of the 16 elbows (69%) with a press-fit implant showed osteolysis of the proximal radius of which the clinical relevance is unknown. A possible cause of this osteolysis can be polyethylene wear (PE). Histological evidence of PE wear in bipolar implants was reported by O’Driscoll and Herald. However, it is unlikely as the mean follow-up period of these patients (28 months) is too short to cause significant wear debris and it was not seen in the elbows with a cemented implant, of which the mean follow-up period was significantly longer (36 months). It is likely that stress shielding is the most important factor for the osteolysis of the proximal radius in the press-fit group: The short, rigid stem of the press-fit design is more prone to stress shielding, compared to the long, thinner, more flexible stem of the cemented implant. The clinical relevance of the proximal osteolysis is unknown, so long-term follow-up results are indicated. In conclusion, the functional results of the cemented and press-fit bipolar radial head prosthesis are generally good, but the clinical relevance of the proximal osteolysis associated with the press-fit implant has to be investigated.
REFERENCE LIST


