Radial Head Fractures

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11.1 Introduction

Radial head fractures are the most common elbow fractures, accounting for 20–30 %. Typically, the fractures evolve from a fall on the outstretched hand with the elbow extended and the forearm in pronation. The role of the radial head as an important stabilizer of the elbow joint has been recognized in the last decade. Sixty percent of the axial load transmitted through the elbow is conducted through the radial head. Furthermore, the radial head is an important stabilizer against valgus stresses. While the medial collateral ligament (MCL) is the primary stabilizer against valgus stress, the role of the radial head emerges when the MCL is torn. These findings have led to a change in treatment recommendations.

11.2 Diagnosis

Patients present with a typical history. Pain and swelling is found over the lateral aspect of the elbow joint as the radial head is palpated. The distal radioulnar joint must be examined closely to exclude an interosseous membrane tear, the so-called Essex-Lopresti lesion. Flexion and extension may be limited due to hemarthrosis. Forearm rotation is usually sustained but may be limited by a mechanical block caused by a displaced radial head fragment. The medial elbow joint space is carefully palpated to exclude an injury of the MCL. Furthermore, elbow stability is tested if possible. The assessment of ligamentous injuries is important, as these influence the treatment significantly. It is well known that comminuted radial head fractures are especially associated with a high percentage of capsuloligamentous injuries.

Lateral and anteroposterior (a.p.) radiographs are performed. In case of significant loss of extension caused be hemarthrosis, two a.p. pictures may be needed: one of the humerus and one of the proximal forearm. The radiocapitellar view is helpful to evaluate radial head fractures. As plain radiographs often underestimate the number of fragments and degree of displacement, a computed tomography (CT) scan is useful to assess fragment size, number, and displacement. If there is any evidence for an injury of the interosseous membrane, bilateral a.p. radiographs of the wrist should be performed to determine the ulnar variance.

11.3 Classification

The most common classification is the Mason classification, which was later modified by Johnston (Fig. 11.1):

Type I	Not or minimally displaced two-part fracture (<2 mm)
Type II	Displaced two-part fracture (>2 mm)
Type III	Fractures with more than two fragments
Type IV	All fractures associated with elbow dislocation

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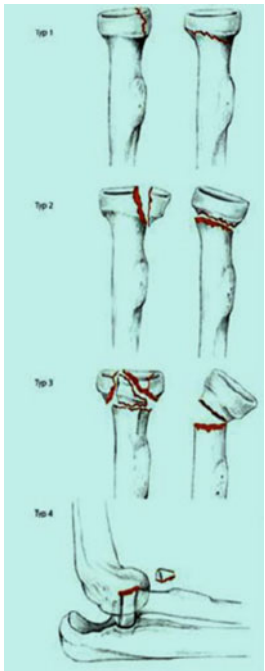


Fig. 11.1 Mason classification modified by Johnston

Another classification was developed by Hotchkiss, aiming to deduce a direct treatment recommendation according to the fracture type:

Type I	Not or minimally displaced fracture (<2 mm) of the head or neck No mechanical block Displacement less than 2 mm or marginal lip fracture
Type II	Displaced fracture (>2 mm) of the head or neck Mechanical block Without severe comminution (technically possible to repair by ORIF)
Type III	Severely comminuted fractures Judged not repairable by ORIF on basis of radiological or intraoperative appearance Usually requires excision for movement

The problem with Hotchkiss' classification is division between type II and III fractures. The border between type II and III is set differently among surgeons depending on their experience, fracture morphology and bone quality, available implants, and patient expectations. Therefore, this classification has not established itself in the current literature. The AO classification did not gain recognition because of its complexity and the lack of treatment recommendations.

In addition to the above-mentioned characteristics of radial head fractures, the treatment is strongly influenced by the associated injuries. The most common were summarized by Ring et al.:

1. Fracture of the radial head with posterior dislocation of the elbow
2. Fracture of the radial head with MCL rupture or capitellar fracture
3. Terrible triad injuries (radial head and coronoid fracture and MCL rupture)
4. Posterior transolecranon fracture dislocation (posterior Monteggia-like lesion)
5. Fracture of the radial head and interosseous ligament rupture (Essex-Lopresti)

11.4 Treatment

11.4.1 Conservative Treatment

Mason type-I fractures are treated conservatively. The injured arm is immobilized with a sling or cast for a few days. Afterwards, early active exercises are initiated. Good results can be expected in 85–95 % of the patients with a Mason I fracture. If normal range of motion does not return, a mechanical block must be excluded. A mechanical block caused by a displaced fragment is an indication for arthroscopic excision. Late excision of loose bodies does not affect the outcome. Diagnosis can be done by infiltrating local anesthetic in the elbow joint to allow for more aggressive passive forearm rotation.

11.4.2 Operative Treatment

11.4.2.1 Mason II

The treatment of choice of Mason type-II fractures is open reduction and internal fixation. Fractures of the radial head should be stabilized with either cortical screws (1.2–2.0 mm) or resorbable pins. Attention must be paid to the safe zone. The safe zone is the nonarticular part of the radial head that does not come into contact with the sigmoid notch of the proximal ulna during forearm rotation. With the forearm in neutral position, the safe zone is centered 10° anterior to the lateral side of the radial head. When the screws need to be placed outside the safe zone, they should be countersunk beneath the articular surface. Alternatively, headless compression screws can be used to avoid soft tissue irritation and interference during forearm rotation. Radial neck fractures can either be stabilized by crossed screws or, especially in case of metaphyseal defects, by plates. Plates should be placed in the safe zone, too. Low-profile plates should be used to avoid

soft tissue irritation, especially of the annular ligament. Screws inserted in the radial head should not penetrate the contralateral cartilage because the screw tip would then come to lie within the proximal radioulnar joint and may there damage the cartilage. As a significant amount of the radial head's blood supply is running through the periosteum, extensive detachment during ORIF should be avoided. If the fragment is not amenable to refixation, fragment resection can be performed for fragments smaller than 25 % of the radial head's surface. Good results can be expected from ORIF of Mason II fractures.

11.4.2.2 Mason III + IV

The optimal treatment of comminuted radial head fractures is still a matter of discussion. The following options exist:

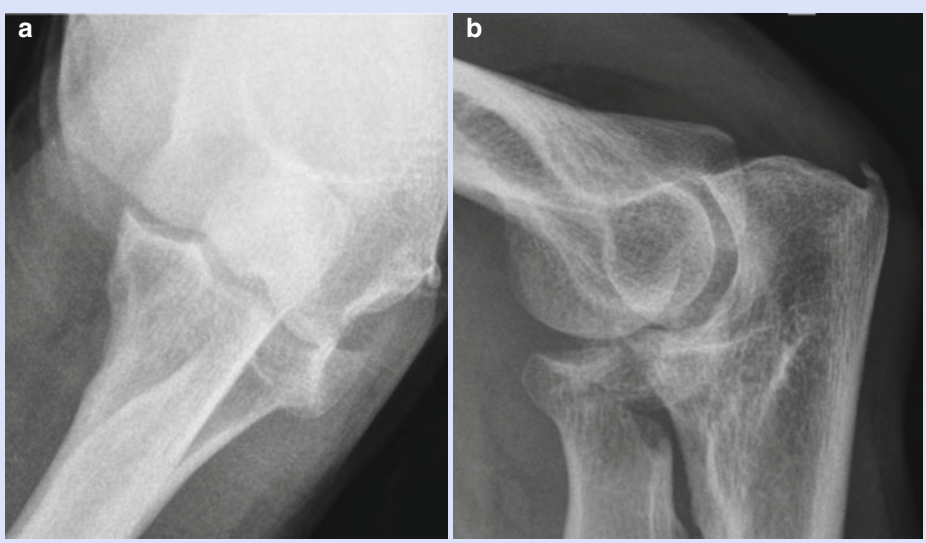
Open Reduction and Internal Fixation

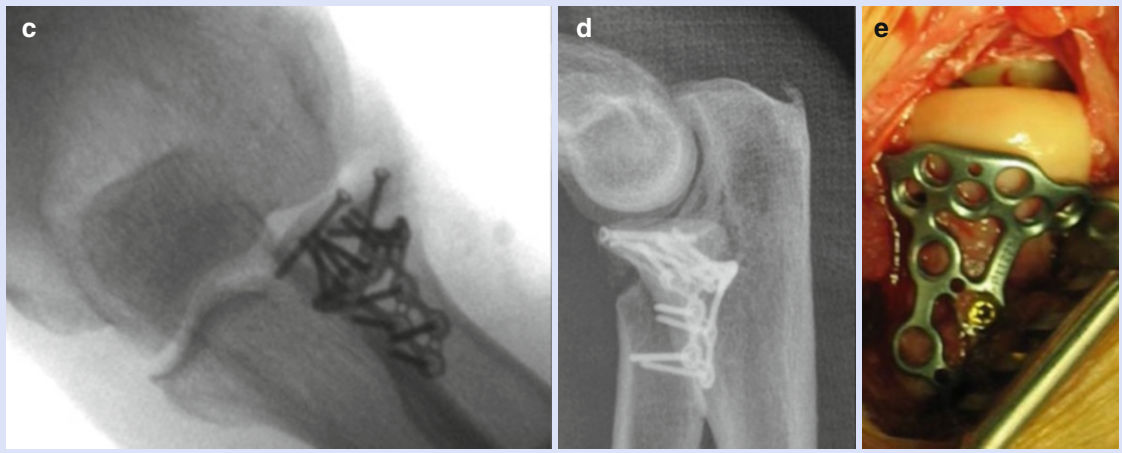
As the important role of the radial head as stabilizer of the elbow joint has been recognized, the interest in preserving and repairing the radial head has steadily increased. Open reduction and internal fixation of radial head fractures is recommended whenever it is possible to achieve an anatomic reduction and stabile fixation. After exposure, the fragments are carefully reduced with respect to the periosteum. The intact radial head fragment acts as a scaffold for the displaced fragments. If there is an additional neck fracture, the head fragments should be reduced and fixed first. Thereafter, the reconstructed head is correctly fixed to the neck with plate and screws. Metaphyseal defects can be filled with cancellous bone from the capitellum or olecranon. False fixation of the head to the neck may lead to limited ROM.

Not all radial head fractures can be restored with ORIF. There is no evidence of which radial head fractures are still amenable to ORIF and which ones are not. Ring suggested that radial head fractures with more than three fragments should not be repaired since he observed a high complication rate and poor clinical results in these patients. This was because unstable fracture fixation ORIF led to radial head necrosis, nonunion, and secondary loss of fixation. However, because the possibilities of ORIF have significantly improved, special locking plates have been developed, especially for the maintenance of radial head fractures. In our own biomechanical study, we found that these low-profile locking plates provide greater stability than conventional plates. In our opinion, these implants will extend the indications for ORIF of radial head fractures.

Case 1

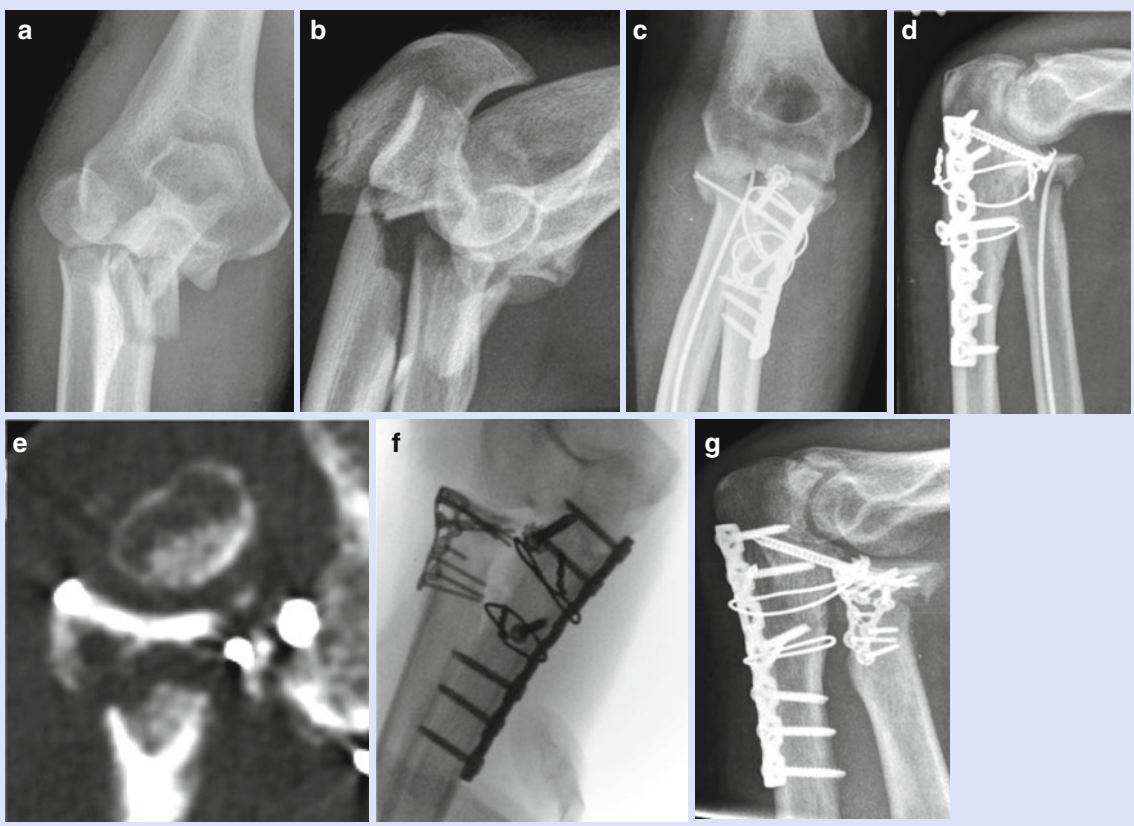
A 59-year-old male patient had a Mason III fracture with a severely dislocated fragment (**a**, **b**). After reconstruction of the radial head with two free screws, the head was fixed to the neck with a locking radial head buttress plate (Medartis, Switzerland) (**c**, **d**). This locking plate is placed beneath the radial head's articular surface. The intraoperative situs is shown in (**e**) (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)





Case 2

A 35-year-old male patient suffered a fracture dislocation of his right elbow (**a**, **b**). While the ulna healed, the proximal radius did not unite because of insufficient stability (**c–e**). When the patient was introduced to our department, he suffered from painful motion caused by the intra-articular lying Prévot nail with intraarticular penetration. The nail was removed and a plate osteosynthesis was performed with a locking radial head rim plate (Medartis) together with a cancellous bone graft from the capitellum (**f**, **g**) (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)



Radial Head Resection

In severely comminuted radial head fractures, ORIF may technically not be possible. In these patients, resection of the radial head is a treatment option. This should only be considered in case of isolated comminuted radial head fractures. But comminuted radial head fractures usually are associated with capsuloligamentous injuries. These capsuloligamentous injuries are not accommodated sufficiently with resection of the radial head alone. Instability will be the result, ending up in a painful elbow and wrist. Fluoroscopic varus, valgus, and axial stress examination should be performed carefully after radial head resection. If there is any doubt of stability, metallic radial head replacement should be performed.

Radial head replacement may be superior to radial head resection, even in isolated comminuted radial head fractures. As 60 % of the axial loads are transmitted through the radiocapitellar joint in the inact elbow, the ulnohumeral joint has to bear all the loads after radial head resection. As a consequence, a high percentage of patients show radiographic evidence of osteoarthrosis. These findings are consistent with different biomechanical studies that reported altered kinematics and decreased elbow stability after radial head resection compared with intact, repaired, and replaced radial head. Therefore, radial head replacement may be superior to radial head resection even in isolated comminuted radial head fractures.

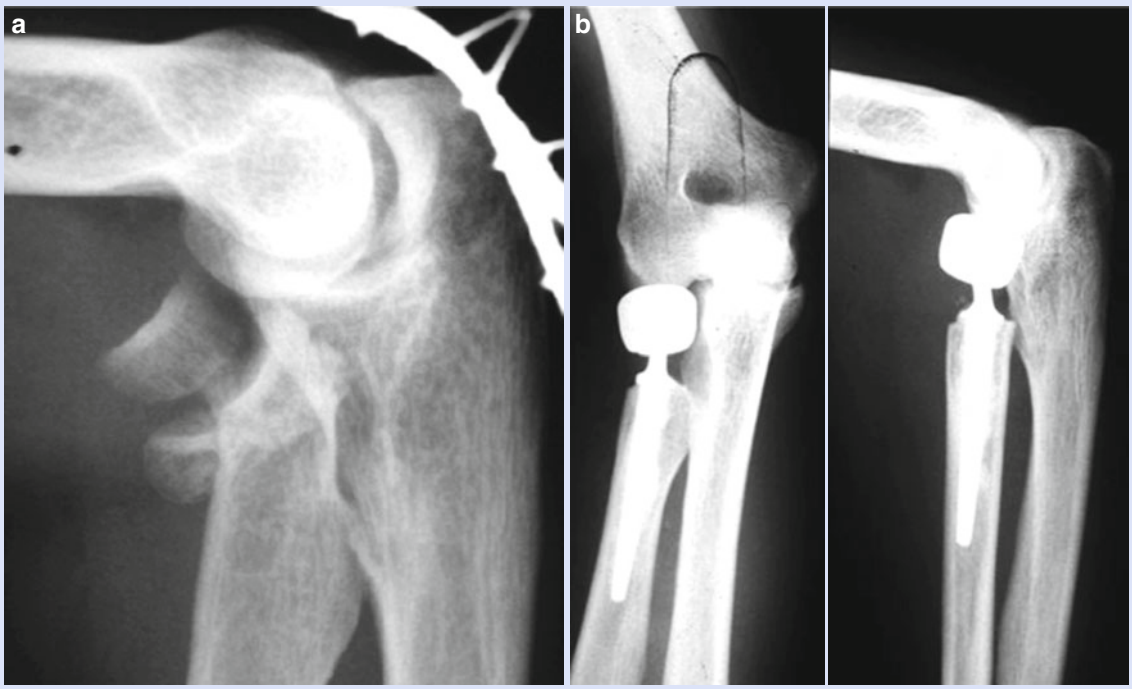
Prosthetic Replacement

Metallic prosthetic replacement is considered the treatment of choice for the irreconstructible radial head fracture. A variety of different metallic implants are available. Current concepts comprise monopolar versus bipolar and cemented versus cementless designs. Radial head arthroplasty has proven to restore elbow stability for monopolar as well as bipolar metal implants. It has therefore superseded radial head resection as the treatment of choice for irreconstructible radial head fractures. In many studies, encouraging short-term results have been reported for all implants, but there still exists a lack of information concerning long-term results. Studies comparing the different designs are not available yet.

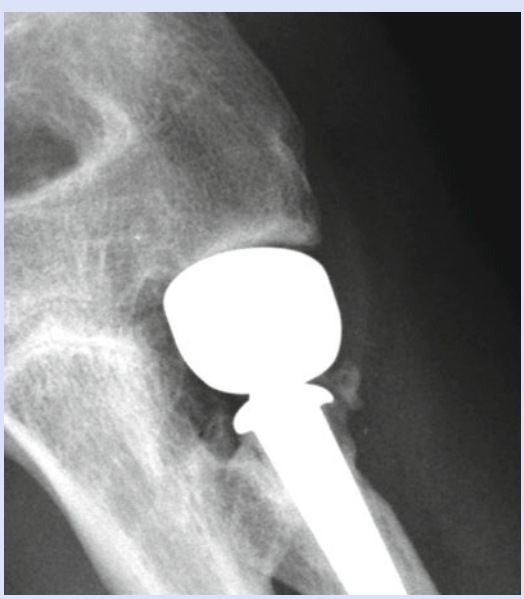
Implantation is demanding. There are some aspects that need to be addressed carefully to assure good clinical results. The most important points are the choice of the right implant size and implantation height. Several biomechanical studies have been performed to investigate this issue. Different sizes and orientations of radial head prostheses were found to essentially alter kinematics and load transmission of the elbow and wrist. This goal is difficult to achieve and is especially complicated by instability resulting from rupture of the MCL or interosseous membrane. Another problem is the fact that the radial head morphology is complex and is not yet perfectly imitated by currently available implants. The lesser sigmoid notch has been validated as a reference point for correct implantation of radial head prosthesis. Overstuffing of the elbow joint may lead to prosthesis dislocation and premature capitellar degeneration. After implantation, the full range of motion is assessed and the radiocapitellar contact is judged by the surgeon. Furthermore, the medial ulnohumeral joint space should be checked fluoroscopically for parallelism as well as distal radioulnar alignment and ulnar variance.

Radiocapitellar hemiarthroplasty is an option in case of concomitant capitellar cartilage damage. Radiocapitellar hemiarthroplasty is also possible in premature radiocapitellar osteoarthrosis after implantation of a radial head prosthesis.

Case 3
Patient with an irreconstructible radial fracture (**a**) was treated with radial head arthroplasty (Tornier, France) (**b**) (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)



Case 4
Capitellar erosion resulting from overstuffing of a radial head prosthesis (Tornier) (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)



Treatment in the Setting of Associated Injuries

Fracture of the Radial Head with MCL Rupture and/or Capitellar Fracture

The radial head needs to be repaired or replaced. The LCL can be addressed through the same approach. The MCL usually does not need to be fixed, only in cases of persistent instability after ORIF or replacement. In some cases, a hinged external fixation must be performed additionally.

Terrible Triad Injuries (Radial Head and Coronoid Fracture and MCL Rupture)

Stable fixation or replacement of the radial head is required. Coronoid fractures larger than 10–30 % of the coronoid height should be fixed.

Transolecranon Fracture Dislocation and Monteggia-Like Lesions

The ulna fracture must be fixed first. Exact reduction is required to avoid alterations of the proximal radioulnar and radiocapitellar joint, which may lead to chronic instability.

Fracture of the Radial Head and Interosseous Ligament Rupture (Essex-Lopresti)

ORIF of the radial head should be performed whenever possible. If stable reconstruction is not possible, the radial head needs to be replaced. Major attention has to be paid to correct implant size and position as mentioned earlier.

11.4.3 Postoperative Rehabilitation

Active and active-assisted physiotherapy should be initiated as early as possible. Time of splinting should not exceed 2 weeks. However, exercises should begin early postoperatively. Varus and valgus stresses as well as resistive exercises should be omitted for 6 weeks. Forearm rotation should be performed in 90° of elbow flexion to protect the collateral ligaments. During extension exercises, the LCL is protected in pronation, the MCL in supination.

11.4.4 Complications

Comminuted radial head fractures carry a high potential for complications. Besides the above-mentioned specific complications of ORIF, radial head resection, and replacement, complications occur regardless of treatment. The most common is elbow stiffness. Furthermore osteoarthritis, heterotopic ossifications, and posterior interosseous nerve irritation occur.

Conclusion

Radial head fractures are the most common elbow fractures. Nondisplaced fractures usually occur in isolation; displaced fractures come along with a high percentage of ligamentous injuries and concomitant elbow fractures such as the coronoid, capitellum, and proximal ulna.

Mason I fractures can be treated conservatively. Mason II fractures are handled by ORIF. Both lead to good results. Comminuted radial head fractures remain problematic. As these come with a high percentage of concomitant fractures and capsuloligamentous injuries, which need to be known, a concise clinical evaluation of the elbow joint is required. A stable elbow joint needs to be restored, either by ORIF or metallic prosthetic replacement of the radial head. As the radial head is an important stabilizer of the elbow joint – especially in the context of concomitant ligamentous injuries – its resection may lead to pain, limited range of motion, and instability. Radial head resection should not be performed in the acute fracture situation anymore. The treatment of choice should be ORIF with special locking radial head plates, regardless of the number of fragments, as long as a stable fracture situation can be achieved. If this is not possible, prosthetic replacement should be performed. Associated injuries need to be adequately addressed to achieve good clinical results. Prognosis is very good for simple Mason I and II fractures and deteriorates with increasing fracture types, radial head comminution, and associated injuries.

Case 5

Patient with progressive pain caused by osteoarthritis after radial head arthroplasty (**a**) was converted to radiocapitellar hemiarthroplasty (Tornier, France) (**b**) (© Klaus Burkhart, Lars Müller, Köln; Pol Rommens, Mainz)