Primary Radial Head Arthroplasty

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Introduction

Radial head arthroplasty has become a reliable treatment option for acute radial head fractures. There has also been expanded use in the setting of radial head malunion and nonunion, elbow instability, and arthritic conditions. Radial head fractures are relatively common with a reported incidence of 55 per 100,000 people in one population-based study [1], and they have been found to represent up to 33% of all fractures of the elbow [2]. A bimodal age distribution, mechanism of injury type, and sex distribution are present, with a subset of younger, typically male patients with high-energy trauma as well as a subset of older, typically female patients with low-energy trauma, often due to a fall from a ground level height [1]. With simple falls, the radial head is most often fractured with the arm in a pronated and partially flexed position which causes the radial head to transmit the force of the fall to the capitellum [3].

The most commonly utilized system for classification of radial head fractures was originally described by Mason [4] with a subsequent modification made by Johnston [5]. More recently, Hotchkiss [6] added a quantifiable value to the degree of displacement used to determine classification of radial head fracture. Mason type I injuries are nondisplaced or minimally displaced (<2 mm) injuries to the radial head or neck with no mechanical block to motion; type II injuries are fractures displaced greater than 2 mm without comminution; type III injuries are comminuted and displaced injuries; and type IV injuries are radial head fractures in the setting of concomitant ulnohumeral dislocation [Fig. 5.1] [3, 7]. Further modification of the Mason classification system was made by van Riet and Morrey [8] to quantify associated lesions about the elbow such as medial ligament injury, lateral ligament injury, and associated fractures to the humerus and ulna.

A number of treatment options exist based on the fracture classification and associated bony and soft tissue injuries. Simple, nondisplaced injuries can often be managed nonoperatively with a short period of immobilization for comfort, typically in a sling, followed by progressive

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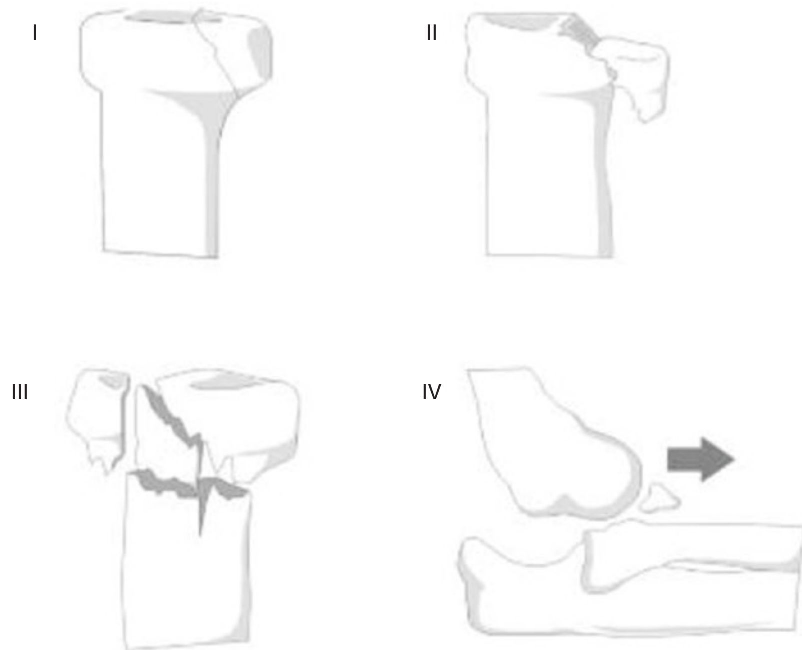

Fig. 5.1 Mason-Johnston classification of radial head fractures. Type I, nondisplaced or minimally displaced; type II, displaced and angulated; type III, comminuted and displaced; and type IV, concomitant ulnohumeral dislocation. Originally published in Pires et al. [7]. (This is an open-access article distributed under the terms of the Creative Commons CC BY license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited)

elbow range of motion. The examiner should assure that the elbow is not hindered by a bony block to motion, and the patient is encouraged to engage in early active motion, as the biggest risk of this injury is stiffness. Management of more complex fractures is highly variable, and options may include nonoperative care, fragment excision or radial head excision, open reduction internal fixation, and radial head arthroplasty. Radial head arthroplasty has become a reliable option for management of non-reconstructable fractures, nonunions, malunions, and, in some cases, primary radiocapitellar arthritis. Recent improvements in our understanding of the nature of these injuries, appropriate technical considerations, and treatment of associated injuries, as well as in some cases implant improvements, have advanced use of this procedure and made it a reliable and commonly used procedure.

Anatomy and Biomechanics

The radial head is an eccentric concave structure that articulates with the convex capitellum. The outer portion of the radial head articulates with the lesser sigmoid notch of the ulna, and this portion is identified by thick articular cartilage. The radial head is elliptical rather than truly circular. Functionally, the elliptical nature of the radial head acts to produce a cam effect which translates the radial shaft radially during pronation [9]. The radial head is angled from the radial shaft on average 16.8°, but this is highly variable ranging from 6° to 28° [10].

Biomechanically, the radial head plays a role in load transmission, as well stability both of the elbow and axial stability of the forearm.

It has been shown that up to 60% of the load experienced by the forearm is transferred to the humerus through the radiocapitellar joint [11]. The elliptical nature of the radial head also plays a role in how load is experienced by the proximal radius. Load transmission is highly variable, based on position of the elbow in flexion versus extension, position of pronation and supination, and whether the elbow experiences a varus or valgus stress. Studies have shown that there is as much as a 10% decrease in load transmission through the radiocapitellar joint with a varus stress [12, 13]. While load transmission through the radiocapitellar joint decreases with varus stress, distraction forces with the elbow in varus are common [14]. This is important to consider in the post-operative setting.

A number of factors play an important role in maintaining appropriate elbow stability including the radiocapitellar and ulnohumeral articulations, their surrounding ligamentous structures, the coronoid, and the interosseous membrane [Fig. 5.2] [15]. The role of the anterior band of the medial collateral ligament as a primary stabilizer of the elbow to valgus stress is well documented [16, 17] with the radial head functioning as a secondary stabilizer. Both ligamentous and proximal radial structural integrity (either with native radial head or radial head arthroplasty) are necessary to confer elbow stability against valgus stress at time zero. This has been demonstrated in a number of studies that showed that radial head arthroplasty eliminated valgus instability in the ligamentously intact elbow; however, radial head arthroplasty could not fully eliminate valgus instability when the medial collateral ligament was compromised [18–21]. Coronoid fractures have also been found to play a role in valgus stability given that the anterior band of the medial collateral ligament inserts on the sublime tubercle at the base of the coronoid.

Posterolateral stability of the elbow is complex and relies on the integrity of both ligamentous and osseous structures to ensure proper stability. The primary stabilizer against posterolateral elbow instability has been shown to be the lateral ulnar collateral ligament (LUCL) [22, 23]. As with valgus stability of the elbow, the radial head plays a significant role as a secondary stabilizer against posterolateral instability at the elbow. The so-called "terrible triad" injury of the elbow consisting of elbow dislocation, radial head fracture, and coronoid fracture has significant implications on the posterolateral rotatory stability of the elbow. Not only does elbow dislocation often frequently result in disruption of the LUCL, but coronoid fracture leads to further instability. This is well demonstrated by the fact that both radial head arthroplasty and coronoid fracture fixation (in fractures of at least 50% of the coronoid) were necessary to fully restore elbow stability [24].

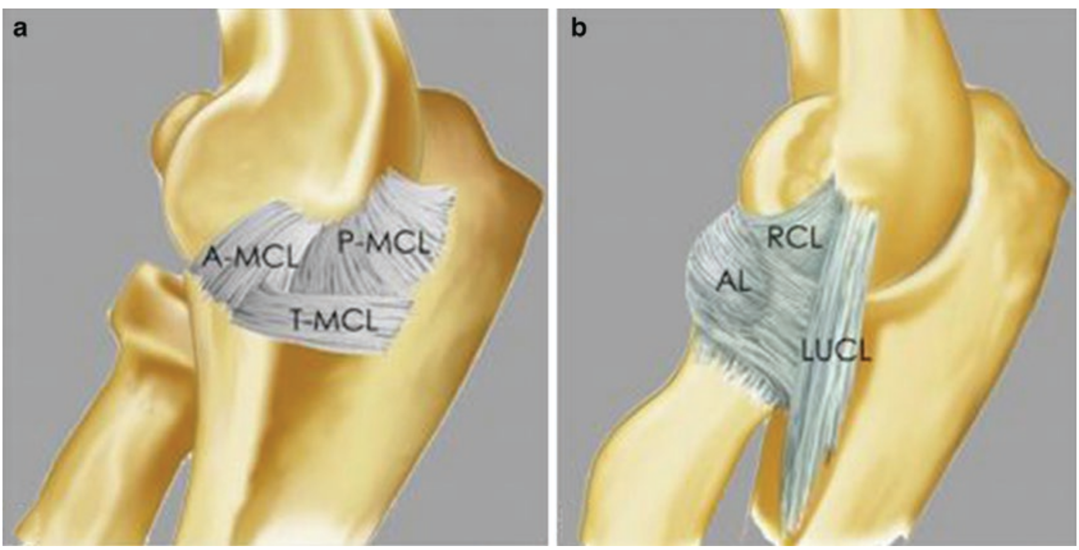

Fig. 5.2 Illustrative representation of the medial (**a**) and lateral (**b**) ligamentous complexes of the elbow. A-MCL anterior band of the medial collateral ligament, P-MCL posterior band of the medial collateral ligament, T-MCL transverse band of the medial collateral ligament, AL annular ligament, RCL radial collateral ligament, LUCL lateral ulnar collateral ligament. Originally published in Acosta Batlle et al. [15]. (This is an open-access article distributed under the terms of the Creative Commons CC BY license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited)

Finally, axial forearm stability is important to consider when discussing the status of the radial head and radial head arthroplasty. The radial head is crucially important to maintaining axial stability of the radius. Radial head fracture, especially severely comminuted fractures, has been shown to significantly affect axial radial stability [25]. Several studies have demonstrated the importance of additional structures in the forearm and wrist in maintaining axial radial stability, especially the interosseous membrane of the forearm and triangular fibrocartilage complex (TFCC) [26–28]. The interosseous membrane is a fibrous tissue complex running obliquely from the radius to the ulna which transmits forces between the radius and ulna and contributes to axial stability to the forearm [29]. The TFCC at the ulnar side of the wrist plays a significant role in maintaining not only normal wrist biomechanics but also forearm and elbow biomechanics [30].

Given the complex interplay of osseous and ligamentous structures in the elbow in conferring stability, it is important to consider the status of these structures during consideration of radial head arthroplasty.

Preoperative Workup and Associated Injuries

As previously discussed, radial head arthroplasty is most commonly performed in the setting of a comminuted unreconstructable radial head fracture. While isolated radial head fractures do occur, it is important to be alert to the presence of concomitant fractures and/or ligamentous injuries. Studies have shown a relatively low rate of associated injury in nondisplaced or minimally displaced radial head fractures; however, the rate of concomitant bony or soft tissue injury increases substantially in the setting of displaced or comminuted radial head fractures [31, 32].

Osseous and cartilaginous injuries about the elbow are common in the setting of radial head fractures. Chondral or osteochondral injuries to the capitellum can occur in the presence of radial head fractures and may be underappreciated. One study noted that around a half of capitellar injuries were found to have associated radial head injuries, but only 2% of radial head fractures were found to have associated capitellar injury [33]. A variant of the Monteggia fracture has been identified in which a proximal ulna fracture is found to be associated with radial head fracture, rather than with just radial head dislocation alone. The presence of this injury pattern has been shown to result in poorer clinical outcomes when compared to traditional Monteggia-type injuries with radial head dislocation alone [34]. In 15% of patients with radial head fractures, a concomitant coronoid fracture has been documented [32]. Smaller coronoid fragments less commonly result in elbow instability but can be easily missed on plain radiographs. Larger fracture fragments are more easily recognized on basic imaging and clinically often result in substantial elbow instability, especially when associated with radial head fracture [35]. The rate of ulnohumeral elbow dislocation associated with radial head fracture has been reported to be between 10 and 15% [32]. Combined radial head fracture, elbow dislocation, and coronoid fracture have been term the “terrible triad” injury.

Ligamentous injury about the elbow in the presence of radial head fracture is relatively common and may not be recognized by initial clinical examination alone. Davidson et al. [31] performed valgus stress radiographs on patients with radial head fractures. They reported that no patients with nondisplaced or minimally displaced injuries had associated medial collateral ligament injuries. In patients with displaced fractures, 71% were found to have associated medial collateral ligament injuries, and in patients with comminuted injuries, 91% were found to have injury to the medial collateral ligament. Johansson et al. [36] utilized arthrography and reported medial collateral ligament or capsular injury in 4%, 21%, and 85% of Mason I, II, and III injuries, respectively. Finally, Itamura et al. [37] performed MRI on a series of 24 patients with Mason II or III fractures. They reported disruption of the medial collateral ligament in 54%, disruption of the lateral ulnar collateral ligament in 80%, disruption of both ligaments in 50%, capitellar osteochondral defects in 29%, capitellar bone bruises in 96%, and loose bodies in 92%.

The presence of a radial head fracture should prompt evaluation for concomitant ipsilateral upper limb injuries. About 6% of patients with radial head fractures were found to have concomitant ipsilateral hand or wrist fracture [32, 38]. The Essex-Lopresti injury is a radial head fracture with associated injury to the interosseous membrane of the forearm which results in longitudinal instability at the distal radioulnar joint [Fig. 5.3]. This injury pattern is often missed in the acute setting and more often presents as a chronic injury [39–41]. Regardless, missing this diagnosis can result in pain, stiffness, and weakness; thus, early recognition is of crucial importance. In addition to standard plain radiographs of the elbow, forearm, and wrist, obtaining bilateral anteroposterior grip views of both wrists in pronation in the more chronic setting has proven to be useful in comparing the degree of ulnar-positive variance which can suggest a possible disruption of the interosseous membrane [42]. Advanced imaging in the form of MRI and ultrasound has been suggested to have greater than 80% sensitivity in diagnosing interosseous membrane disruption in Essex-Lopresti injuries [43]. Intraoperatively, axial stability can be assessed by performing a "shuck" test by placing axial stress to the radius and assessing motion compared to the ulna [44] or by the radial pull test [45].

Evaluation of a radial head fracture includes plain film radiographs of the injured elbow, examination of the "joint above and joint below" including clinical palpation and history with imaging as indicated, and palpation for tenderness at the forearm, wrist, and medial

Fig. 5.3 AP elbow and wrist radiographs demonstrating a radial head fracture (left) and longitudinal instability resulting in ulnar-positive variance as seen in Essex-Lopresti injuries

and lateral elbow. Computed tomography (CT) scans may be very helpful to determine the source of bony fragments as plain film radiographs may be difficult to interpret, as well as presence or absence of associated injuries, the amount of comminution and number of fracture fragments. Three-dimensional reconstructions with joint subtraction views, may be particularly helpful.

Indications for Radial Head Arthroplasty

Acute Radial Head Fracture

Many radial head fractures (Mason I and many Mason II fractures) are amenable to nonoperative care. However, in the setting of some Mason II injuries, particularly those with a block to motion, open reduction internal fixation (ORIF) is generally the preferred treatment of reconstructable radial head fractures. Most Mason III fractures are best treated by radial head excision or arthroplasty. Ring et al. [46] found that all 15 patients with non-comminuted Mason-type II fractures had satisfactory results from ORIF. In contrast, 13 of 14 patients with Mason-type III comminuted fractures with more than 3 articular fragments had unsatisfactory results following ORIF. Additionally, many Mason III fractures are accompanied by concomitant injuries which may render the elbow unstable. For this reason, the preferred treatment for fractures deemed not reconstructable (i.e., more than three fragments or significant comminution) is often but not always radial head arthroplasty [47–50]. It is important to recognize patient factors will influence this as well as surgeon factors. Young active patients may have better bone quality to work with, and better healing capacity, and given the implications of a radial head arthroplasty in a young patient with a long expected lifespan, if the radial head can be repaired, this is often favored. Radial head arthroplasty is technically easier than fixation of comminuted multifragmentary fractures, so the element of surgeon skill and facility with repair plays a factor.

Radial Head Fractures with Instability

When medial or lateral collateral ligament injury is discovered in the presence of radial head fracture, the elbow can remain unstable even in the setting of successful closed reduction of an elbow dislocation. Ashwood et al. [51] have demonstrated good outcomes in patients who underwent radial head arthroplasty for fractures not deemed reconstructable in the setting of elbow instability with ligament damage. Medial collateral ligament insufficiency and distal radioulnar joint injury have become well-recognized indications for radial head repair or arthroplasty [44]. Terrible triad injuries have proven to be a definite indication for radial head arthroplasty (when the head is not reconstructable) with lateral ulnar collateral ligament repair and with or without fixation of the coronoid [44, 49].

Radial Head Malunion, Nonunion, or Previous Excision

Symptomatic radial head malunion and nonunion are potentially problematic complications of failed fracture fixation or failure of the nonoperatively managed fracture. Residual articular depression of 2 mm or angulation of 30° can result in a loss of up to 80% of stability at the radiocapitellar joint [52]. While published outcomes are somewhat limited, early data has demonstrated that radial head arthroplasty can be used as a salvage operation in the setting of radial head malunion or nonunion as long as the capitellum is not damaged [53]. Finally, radial head arthroplasty is an option for revision surgery in selected patients who previously underwent radial head excision and have subsequently failed due to proximal migration of the radius with distal radioulnar joint pain, pain from impingement of the radial neck on the capitellum, or valgus instability. When considering radial head arthroplasty in the setting of malunion, it is important to consider whether bony morphology of the radial neck and shaft is amenable to supporting an implant. Significant radial neck angulation and poor residual bone stock are factors to consider as they make radial head arthroplasty more technically challenging. One must also consider the status of the capitellar cartilage. In some settings the capitellar cartilage may be thinned or injured, and may not tolerate the interface of a metallic radial head on this imperfect cartilage, leading to pain.

Essex-Lopresti Injury

Radial head replacement is often done in the setting of concern for axial instability of the forearm, or Essex-Lopresti injury. Essex-Lopresti injuries continue to be a challenge for appropriate diagnosis and treatment. In the acute setting, these are associated with an injury to the lateral side of the elbow, typically a radial head fracture, injury to the interosseous membrane of the forearm, and the TFCC. If the radial head is excised and the true extent of forearm instability is unrecognized, patients may present with ulnar impaction, forearm instability and pain, and impingement at the capitellum-radial neck junction. The management of these injuries is a subject of controversy both in the acute setting and the chronic setting. In the acute setting, typically radial head replacement is a component of the treatment; for patients identified in the chronic setting, radial head replacement may or may not be an appropriate option, as the presence of a metallic implant articulating with a worn capitellar cartilage may not restore forearm stability and may become a source of pain [54]. Current thought in the management of Essex-Lopresti injury is that concomitant TFCC and/or interosseous membrane injury should be treated with repair or reconstruction in order to restore load sharing between the radius and ulna [55].

Contraindications for Radial Head Arthroplasty

Absolute contraindications to radial head arthroplasty are rare and include presence of active infection in the elbow. When radial head fracture is felt to be amenable to open reduction internal fixation, this treatment modality should be pursued as the first option. Capitellar arthrosis is a relative contraindication to radial head arthroplasty. As discussed previously, capitellar articular damage is common in the setting of radial head fracture [37]. Despite this, a subset of patients may have satisfactory outcomes in spite of some degree of capitellar arthrosis. Finally, alternatives to radial head arthroplasty should be considered if there is concern about the ability of the proximal radius to support an implant whether that is due to significant malalignment, surgical absence, or fracture propagation along the neck/shaft or bone resorption.

Surgical Approaches

The patient is positioned supine on a standard operative table. A small bump can be utilized under the scapula of the operative extremity in order to more easily position the arm across the patient's chest. The operative table can be slightly tilted away from the surgeon to further assist with visualization and arm positioning. A sterile or nonsterile tourniquet is applied to the upper arm. The extremity is prepped and draped in the usual sterile fashion.

Although, in the past, a posterior incision was favored as a "utilitarian" approach, the authors favor an incision directly laterally to easily access the radial head with advantages of a smaller incision and less chance of seroma formation. If there is a need to address medial-sided pathology, a separate medial incision may easily be made [56, 57]. A laterally based incision typically runs from just proximal to the lateral epicondyle extending toward the supinator crest of the ulna. Following skin incision, full-thickness skin flaps are created [Fig. 5.4].

Access to the radial head can be achieved through either a Kocher approach between the ECU and the anconeus interval or alternatively a split of the extensor digitorum communis (EDC) tendon. In patients with instability from damage to the LCL, a Kocher approach is preferred as this facilitates ligament repair intraoperatively. In the setting of acute radial head fracture, the LCL and

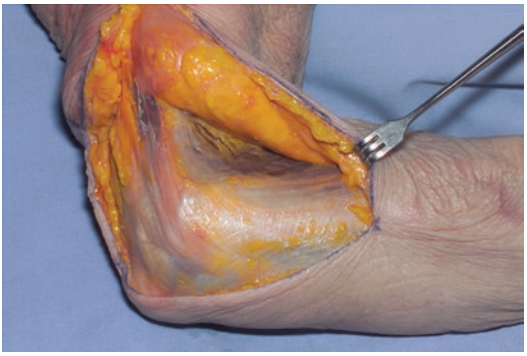

Fig. 5.4 Posterior skin incision utilized and brought down to the antebrachial fascia on the lateral elbow. (Permissions obtained from Wolters Kluwer)

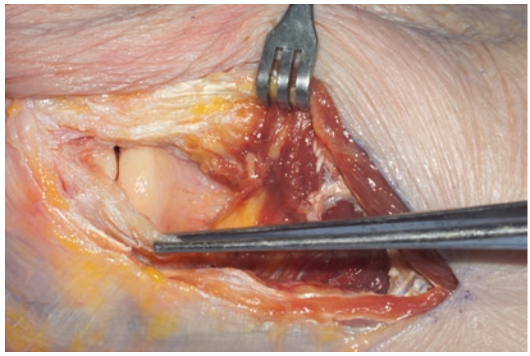

Fig. 5.6 Capsular incision at the anterior border of LUCL to reveal the radial head. (Permissions obtained from Wolters Kluwer)

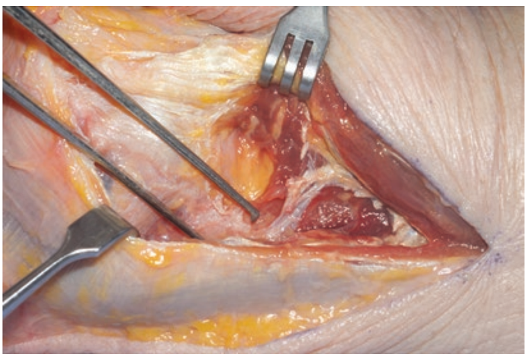

Fig. 5.5 Identification of the LUCL in Kocher's interval. The common extensor tendon of the LCL has been elevated to demonstrate this anatomic structure

extensor muscle origin are frequently avulsed from the lateral epicondyle, thus providing a window for the surgeon to utilize to gain exposure to the radial head. In this setting, the surgeon can gently palpate the lateral side of the elbow to identify the disrupted interval and exploit this for exposure, thus "using the approach the patient gives you." When no instability is present, care must be taken by the surgeon to avoid iatrogenic injury to the LUCL if the Kocher interval is used. The interval between the ECU and anconeus can often be found by identifying a fat stripe under the fascia between these two muscles. The fascia is incised from the lateral epicondyle distally taking care to elevate the ECU anteriorly and anconeus posteriorly. The LCL is split centrally protecting the posterior portion of this complex containing the LUCL [Fig. 5.5], and the capsule is incised along the anterior border of the ligament, approximately 1 cm above the crista supinatoris. The extensor origin is carefully freed from the LUCL and retracted anteriorly with the radial collateral ligament [Fig. 5.6], taking care not to damage the LUCL as this will iatrogenically cause posterolateral rotatory instability. Care should also be taken to protect the posterior interosseous nerve by maintaining the forearm in pronation especially when retracting anterior structures. Retractors used anteriorly around the radial neck should be used with caution to avoid compression or injury to the posterior interosseous nerve.

In patients with an intact LCL, we highly favor an alternative approach which utilizes an EDC tendon origin split. With this approach, the EDC tendon and underlying radial collateral and annular ligaments are split longitudinally at or just above the mid-aspect or "equator" of the radial head. Care should be taken to avoid making the split too posterior as this can potentially damage the LUCL. The forearm should be maintained in pronation during the approach to avoid injury to the posterior interosseous nerve. Anatomic studies have shown that the posterior interosseous nerve can typically be found at the radial neck around 4 cm from the proximal margin of the radial head; the margin of safety may be increased by pronating the forearm [58]. A recent cadaveric series investigated the "3-finger method of Henry," providing recommendations to the surgeon regarding the "safe" locations of the elbow before one becomes worried about encountering the PIN or the radial nerve distally or proximally [59]. They suggest a safe zone of two fingerbreadths from the radiocapitellar joint to the midpoint of the axis of the radius with the forearm in pronation before the PIN is encountered.

Surgical Technique and Tips

After gaining appropriate exposure to the radial head, the radial head is inspected to determine what treatment is appropriate (excision of fragments, ORIF, or radial head replacement). If radial head arthroplasty is chosen, any free osseous fragments are removed from the wound and preserved on the back table to act as a template for sizing purposes and to ensure that all of the radial head has been excised [Fig. 5.7]. If the radial head has been previously excised or is healed in a malunited state, templating for the diameter of the implant can be done using plain radiographs of the contralateral elbow.

A micro sagittal saw can be utilized to excise a small amount of radial neck to make a more uniform surface for eventual seating of the radial head implant if required. When performing resection of residual head, forearm rotation should be assessed to ensure that resection is performed perpendicular to the radial neck and that the resection is level on all sides.

Fig. 5.7 Excised radial head that has been reconstituted in order to act as a template for implant

Following radial head excision, a "pull test" should be performed to evaluate for longitudinal instability of the forearm [45, 60]. To perform this test, a bone-reduction tenaculum is used to grasp the residual proximal radius. Then, a longitudinal pull of approximately 20 lb is applied in line with the radius. Fluoroscopy can then be used to quantify the amount of proximal migration of the radius. Greater than 3 mm of proximal radial migration with the "pull test" suggests disruption of the interosseous membrane [45].

The longitudinal height of the implant should be judged based on the reconstructed radial head. CT-based anatomic studies have proven useful in determining appropriate radial head height as well. Doornberg et al. [61] demonstrated that the native radial head lies on average 0.9 mm distal to the proximal margin of the less sigmoid notch. Thus, landmarks such as the lateral aspect of the coronoid at the lesser sigmoid notch can be used to determine the appropriate implant height. Care should be taken not to use an implant that is too long as this has been found to result in capitellar destruction and pain [62, 63]. Unfortunately, "overstuffing" of the joint is a common error, particularly in the setting of an elbow with LCL insufficiency. Radiocapitellar gapping has not been found to be a reliable measure of radial height as the LCL is often lax in patients undergoing radial head arthroplasty. Direct visualization of ulnohumeral gapping is a reliable indicator of overstuffing of the radiocapitellar joint; however, fluoroscopy was not found to reliably detect overstuffing [64].

Similarly, radial head diameter should be determined based on the reconstituted radial head that was previously removed from the wound. It has been suggested that the diameter of the implant be slightly undersized compared to the true diameter of the native radial head [50]. Typically the inner "dish" diameter, not the outer "dish" diameter of the native radial head, represents the size of implant that one should choose.

An implant with a diameter that is too large will load on the outer margins of the lesser sigmoid notch, whereas an implant with a diameter that is too small will point load on the central portion of the lesser sigmoid notch [18].

The radial neck is then reamed by hand removing cancellous bone until cortical bone is encountered. Exposure to the radial neck for reaming and implant seating can be facilitated with the use of leverage-based retractors [Fig. 5.8], again taking care to avoid excessive retraction anteriorly to avoid injury to the PIN. These can be placed around the radial neck, taking care to protect the posterior interosseous nerve, to deliver it laterally out of the wound. A variety of stem fixation is available, including press fit, cemented, or intentionally loose stems. We favor intentionally loose stem, smooth stem placement, based upon long-term favorable outcome studies [65]. For these implants, a trial stem one size smaller than the final reamer is selected, and an appropriately sized trial head is attached to the stem. The use of a stem size smaller than the final reamer allows for movement of the stem in the intramedullary canal. This is crucial as the implant functionally acts as a spacer with motion of the radial head being driven by the annular ligament and the articulations of the implant with the capitellum and lesser sigmoid notch. If the implant is found to track improperly through range of motion, it may be necessary to downsize the stem as this would allow for proper rotation of the stem in the medullary canal. It has been shown that movement of the stem in the medullary canal is well-tolerated and radiographic lucencies are not correlated with patient-reported symptoms [53, 66–68]. Intraoperative fluoroscopy can also be utilized to confirm appropriate implant thickness by ensuring that the medial ulnohumeral joint space is parallel on anteroposterior imaging. Additionally, imaging of the wrist may be considered to ensure that ulnar variance is equal bilaterally.

Once fit is found to be satisfactory, the real radial head implant is placed [Fig. 5.9], and the elbow is assessed for range of motion as well as stability. A valgus stress to the elbow should be applied, and if the medial joint space demonstrates opening, then medial collateral ligament injury should be suspected. If instability on the lateral side (LCL) is present, ligament repair should be performed. This often can be done by creating bone tunnels or suture anchors to repair the LCL to the epicondylar origin with the elbow in approximately 30° of flexion and the arm in pronation [18].

Elbow range of motion should be formally assessed prior to wound closure. Cadaveric studies have shown that the radiocapitellar space is reduced with the elbow in flexion when compared to the elbow in extension [69]. Thus, oversizing of the radial head component has the potential to reduce post-operative flexion as a large implant can impinge in the radial fossa of the distal humerus prior to achieving full flexion.

Fig. 5.8 Radial canal delivered laterally for ease with reaming and implant placement. Care should be taken when placing the anterior retractor to avoid damage to the PIN

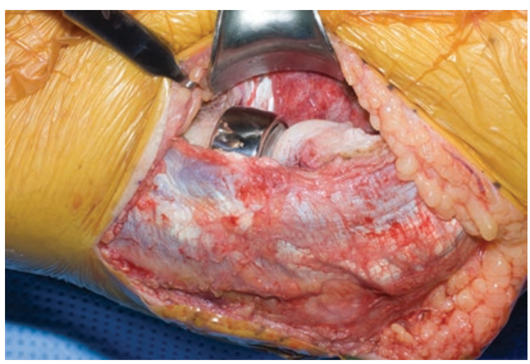

Fig. 5.9 Picture demonstrating an implanted radial head replacement through and EDC split approach with appropriate joint reduction

Post-Operative Management Following Primary Radial Head Arthroplasty

The post-operative management depends largely upon the presence and extent of any concomitant ligament or osseous injuries.

Generally following surgery, the operative extremity should be splinted at approximately 90 degrees, elevated, and rested for several days in order to minimize swelling and reduce the risk of wound dehiscence. Range of motion may begin as early as day one or two following surgery. Patients who have instability on the lateral side are typically immobilized in a position of pronation and flexion; forearm rotation is permitted with the elbow in full flexion only. Gradually the elbow is extended, again depending upon the stability achieved at the time of surgery and the confidence in the repair. Nighttime extension splinting should be utilized to regain terminal extension, beginning around 6 weeks following surgery [50, 70]. Outside of regaining early appropriate range of motion, specific post-operative rehabilitation programs are largely dictated by the presence of concomitant injury and the stability of any additional osseous or ligament repair. Of note, several studies have demonstrated the utility of overhead motion protocols in patients with suspected elbow instability [71–73]. This rehabilitation protocol is designed to convert gravity from a distracting to a stabilizing force in order to maintain congruency at the elbow.

Heterotopic ossification prophylaxis is commonly used following radial head arthroplasty. Heterotopic ossification has been found to occur in up to 43% of patients who experienced fracture dislocations of the elbow [74]; however, little to no data exists on the rate of heterotopic ossification following radial head arthroplasty. Indomethacin has been proposed as the medication of choice to act as prophylaxis against heterotopic ossification and also provide some post-operative pain control [50]. Nevertheless, there remains a paucity of data regarding the efficacy of indomethacin in preventing heterotopic ossification in the elbow, and there is no uniform agreement on the duration, dosage, and timing of this medication. Some patients tolerate indomethacin well, while others find GI upset problematic; thus, routine use of a proton pump inhibitor should be considered. Additionally, while radiotherapy is frequently employed as prophylaxis against heterotopic ossification in other locations about the body [75], there is little support for its use in protecting against heterotopic ossification in the elbow [76].

Post-operatively, plain radiographs consisting of a true anteroposterior and lateral of the elbow can be obtained to ensure appropriate implant position and to act as a baseline for comparison with future radiographs [Fig. 5.10].

Complications

Complications following radial head arthroplasty are not infrequent, but most are minor with little functional consequence. Elbow and forearm stiffness is common following radial head arthroplasty; however, with appropriate rehabilitation a functional range of motion is achieved in most patients. Morrey et al. [77] evaluated 47 consecutive elbows that underwent radial head arthroplasty and subsequently required revision surgery. Revision surgery was indicated for stiffness in 18 elbows. As previously discussed, nerve injury is possible with radial head replacement. This may range from cutaneous nerve injury to major peripheral nerve injury [56]. Maintaining the forearm in pronation and ensuring safe retractor placement are intraoperative techniques that should be utilized to reduce the risk of posterior interosseous nerve injury. Finally, general complications such as infection, weakness, and complex regional pain syndrome are possible following radial head replacement.

Prognostic Factors and Outcomes Following Primary Radial Head Arthroplasty

Implant design has been the focus of much of the outcomes data regarding radial head arthroplasty. This has been well-discussed in the previous chapter. Additionally, given that much of the data

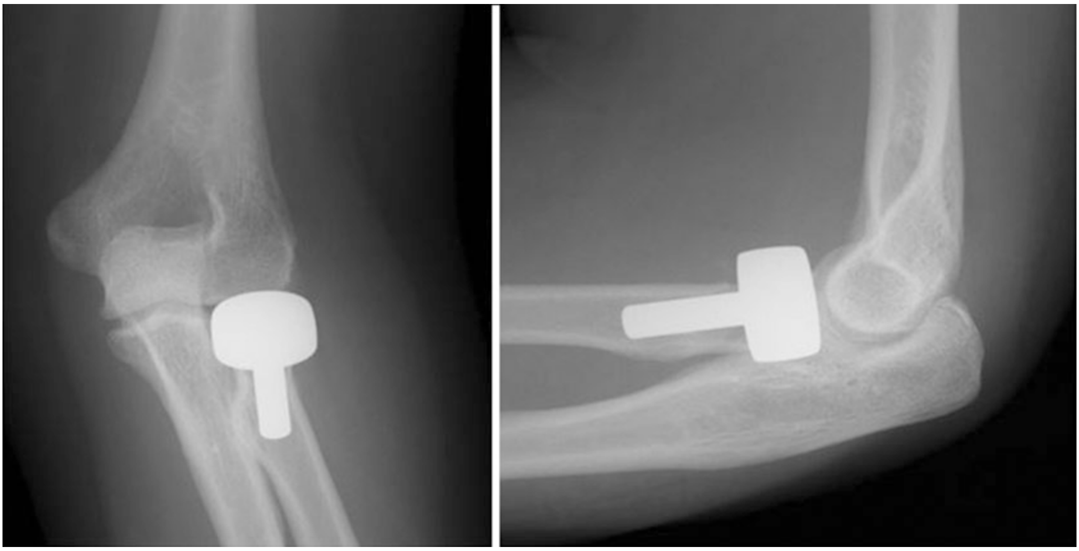

Fig. 5.10 Post-operative AP (left) and lateral (right) radiographs of the elbow. These images demonstrate a parallel medial ulnohumeral joint and an implant well aligned with the capitellum

on outcomes is relatively heterogeneous with regard to implant characteristics, it is difficult to determine if certain patient-specific factors affect outcomes data. Nevertheless, data seem to suggest that there are certain patients or situational factors that exist for predicting outcomes following radial head arthroplasty.

Acute Versus Delayed Presentation

One of the most important prognostic factors for outcomes following radial head arthroplasty is injury chronicity. A recent systematic review by Fowler et al. [78] identified 19 studies looking at outcomes following radial head arthroplasty and calculated a composite mean for Mayo Elbow Performance Score (MEPS) for each included study. They showed higher MEPS (90) for patients treated with radial head arthroplasty acutely when compared to those patients treated in a delayed setting [81]. This is further supported by data compiled by Morrey [44] who cites 92% patient satisfaction when undergoing radial head arthroplasty in the setting of acute fracture versus 48% patient satisfaction in patients who had delayed radial head arthroplasty as a reconstructive technique.

Injury Pattern

Fowler et al. [78] showed no significant difference in pooled MEPS following radial head replacement performed in the setting of isolated radial head injury (89) versus complex injury pattern (87) as long as the concomitant pathology was appropriately addressed intraoperatively. This speaks to the importance of ensuring appropriate preoperative workup as well as performing comprehensive intraoperative assessment of elbow stability [Fig. 5.11].

Return to Prior Level of Activity

Radial head replacement has proven to be a reliable treatment option for a number of surgical indications and has been found to successfully restore functional range of motion and grip strength over time [79]. Dunn et al. [80] sought to evaluate post-operative outcomes in more

Fig. 5.11 Persistent joint instability on radiograph despite radial head arthroplasty

high-demand patients and thus retrospectively reviewed all active duty military members who underwent radial head replacement following radial head fracture. They found that 77% of patients were able to return to active duty military service or sport; however, only half of those patients that did return reported that they were able to return to their preinjury level of function. Jung et al. [81] evaluated 57 recreational athletes who underwent radial head arthroplasty in the setting of radial head fracture and reported a relatively low return to sport rate of only 53% demonstrating that it may be difficult for the average patient to return to high level of activity following radial head replacement.

Summary

Radial head arthroplasty has demonstrated good outcomes and is an appropriate treatment option for acute radial head fractures, elbow instability, and failed fracture reconstruction. Crucial to a successful outcome following radial head arthroplasty are appropriate preoperative workup, knowledge of surgical anatomy, technique of implantation, and rehabilitation. Further research is necessary to improve implant designs to best optimize patient outcomes.

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