ACTA CHIRURGIAE ORTHOPAEDICAE
ET TRAUMATOLOGIAE ČECHOSL., 77, 2010, p. 7–12

Radial Head Arthroplasty

Náhrada hlavičky radia

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SUMMARY

In conclusion, radial head fractures with 3 or more fragments have a high incidence of complications when treated with ORIF including hardware failure, malunion, nonunion, and the need for re-operation. Radial head arthroplasty has demonstrated good success in the treatment of complex, comminuted radial head fractures which are not amenable to non-opeative treatment or ORIF. Success can be optimized by diligent surgical dissection, avoiding inadvertent nerve injury, placement of an appropriately sized implant, repair of associated injuries, and early protected motion.

INTRODUCTION

The use of radial head arthroplasty for the treatment of radial head fractures is an evolving technique. Because radial head fractures account for approximately one-third of fractures about the elbow (19, 28), a proper understanding of management options is essential. Additionally, these injuries can result in functional limitations and debilitating pain. For this reason, appropriate treatment early on in the course of this injury is essential to reduce long-term complications and significant morbidity to the patient (30).

Radial head fractures can occur both in isolation and in association with other soft tissue injuries and/or fractures. The overall injury complex will direct treatment and influence the recovery process. The radial head itself provides intrinsic stability to the elbow, particularly in regards to longitudinal forearm, posterolateral rotatory, and valgus stability (38). Commonly encountered associated injuries include lateral and medial collateral ligament injuries, distal radioulnar joint and interosseous membrane injuries as seen in Essex-Lopresti injuries as well as coronoid and capitellar fractures (11).

Depending on the severity of the radial head fracture, several treatment modalities exist. In 1954 Mason concluded that „the axiom in the treatment of fractures of the head of the radius should be: If in doubt – resect“ (28). Over time, the sequelae of longitudinal forearm instability with Essex-Lopresti injuries following radial head excision had prompted the trend towards open reduction internal fixation (ORIF) of displaced radial head fractures (see figure 1). Despite overall good success with ORIF of radial head fractures (12, 18), cases with multiple fragments, comminution, and nonunions continue to pose a difficult problem (37). In particular, radial head fractures with more than three fracture fragments have been shown to be difficult to fix and have a high predilection towards hardware complications, malunions, nonunions, and the need for re-operation after ORIF (37).

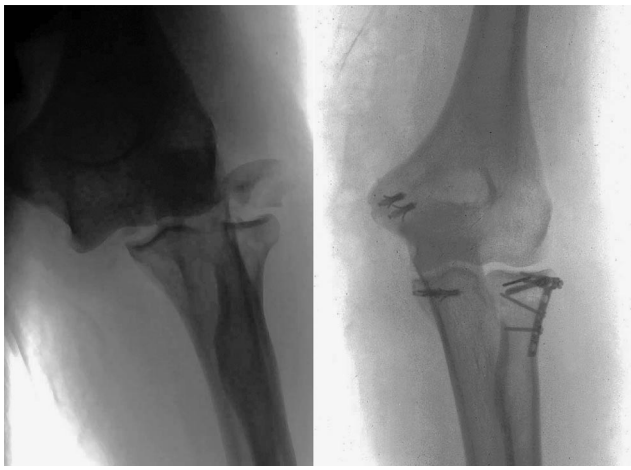

Fig. 1. Radial head fracture in a terrible triad injury of the elbow treated with open reduction internal fixation.

Fig. 2. Radial head fracture treated with a cemented bipolar radial head arthroplasty.

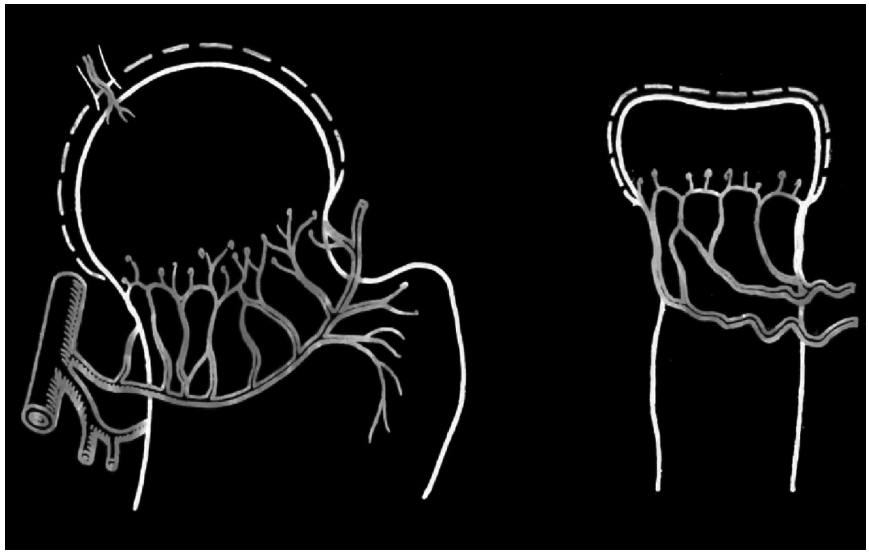

Fig. 3. Illustration of the blood supply to the radial head as compared to the femoral head.

In response to these difficulties, radial head arthroplasty is quickly gaining popularity for the treatment of comminuted radial head fractures (see figure 2). Many types of radial head prostheses exist that have been used over the years. While there was some early literature describing the use of metallic implants (42), the widespread use of metallic implants has only more recently gained universal favor. Cherry described the use of an acrylic prosthesis in 1953. While he noted that this device may prevent proximal migration of the radius and the subsequent strain on the distal radioulnar joint that could result from excision (5), it proved to lack durability. Silicone implants were initially advocated by several authors (2, 27, 45, 31), but were later noted to possess limitations such as, silicone synovitis, debris (46), fracture, and changes in ulnar variance secondary to the excessive flexibility of the implants (3). Metallic radial head implants have supplanted the popularity of silicone implants due to their demonstrated superiority in their functional outcomes (4, 15, 16, 25, 30, 36, 41).

ANATOMY

The radial head is fully covered in articular cartilage and is concave at its center and elliptical in cross section. It angles approximately 15 degrees from its shaft. The radial head rotates around the capitellum. With pronation the radial head moves anteriorly and medially. With supination it moves posteriorly and laterally.

The blood supply to the radial head is tenuous and is akin to the femoral head (see figure 3). There is an arcade of vessels that travel proximally from the capsular base that is supported by the interosseous blood supply. As such, much like the femoral head, fractures of the radial head with comminution and displacement exhibit a tendency towards nonunions and osteonecrosis.

PATHOPHYSIOLOGY OF ELBOW / FOREARM STABILITY

The radial head provides stability to the elbow in multiple directions. The radial head provides longitudinal stability of the radius by blocking its proximal migration. Additional longitudinal stabilizers are the interosseous membrane and the triangular fibrocartilage complex (TFCC); however these are secondary restraints. If the interosseous membrane or TFCC also sustains trauma in cases with concomitant injury to the radiocapitellar joint, treatment must be focused on reconstruction about the elbow to prevent longitudinal instability.

The radial head additionally plays an important role in the inherent varus/valgus stability of the elbow. The primary stabilizer to valgus instability of the elbow is an intact ulnar collateral ligament. The radial head is a secondary stabilizer to valgus stress. Replacement of the radial head in an otherwise ulnar collateral ligament deficient elbow improves lost stability.

Finally, the radial head in combination with the anterior band of the lateral collateral ligament provide posterolateral stability to the elbow. The radial head acts by tensioning the ligament so that the elbow does not dislocate in a posterolateral direction. In addition, care must be taken during surgical approaches to maintain the integrity of the lateral collateral ligament. If it is damaged during dissection, it should be repaired prior to closing.

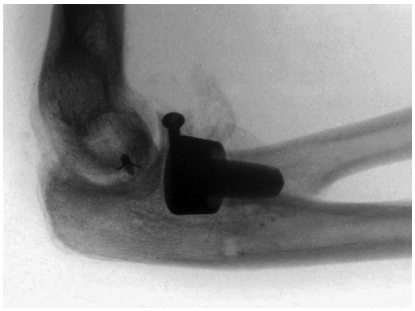

Fig. 4a. Monoblock radial head implant.

Fig. 4b. Modular radial head implant.

Fig. 4c. Bipolar radial head implant.

Fig. 5. Capitellar wear following radial head arthroplasty.

TYPES OF RADIAL HEAD IMPLANTS

Most implants today are fabricated from either cobalt-chromium or titanium. While silicone implants have been used, they have fallen out of favor due to factors such as lack of durability and silicone inflammatory synovitis. Several types of radial head replacements are available. They can broadly be separated into three types (see figure 3):

(1) Monoblock
(2) Modular
(3) Bipolar

Modular implants provide for increased flexibility in implant selection and sizing as well as increased ease of implant insertion. Bipolar implants provide the theoretical advantage of less capitellar wear and stem-shaft loosening with the additional axis of motion (Fig. 4).

The type of stem is also an important consideration. Loose-fitting stems function as a spacer and allow for motion between the stem and shaft. Fixed stems, either press fit or cemented, do not afford for proximal motion and demand diligent anatomic placement to adequately restore normal joint alignment.

SURGICAL INDICATIONS

The indications for radial head arthroplasty depend largely on the severity of the injury. Once again, the degree of bony and soft tissue injury is important factors in determining the need for replacement over excision or ORIF. In defining the indications for radial head arthroplasty, it may be helpful to distinguish between acute and chronic conditions. Acute injuries that benefit most from radial head arthroplasty include injuries resulting in comminution with 3 or more parts, such as those characteristic of Mason type-3 injuries (41), or those that are otherwise deemed unreconstructible due to other injuries resulting in instability (9, 14–16). Mason type-4 injuries, radial head fractures of any type combined with dislocation of the elbow, also demonstrate marked improvement when treated with arthroplasty over excision. Third, radial head arthroplasty is indicated in radial head fractures associated with medial collateral, lateral collateral or interosseous ligament injuries (6, 24, 35, 39). Finally, arthroplasty is indicated when the fracture is associated with capitellar fractures also requiring internal fixation (23). As mentioned, there is also a role for radial head arthroplasty in the treatment of chronic conditions of the elbow. These conditions include radial head malunions and nonunions as well as possibly in the treatment of the rheumatoid elbow. However, complications such as the accelerated prosthetic degeneration have been described (46). In addition to treating malunions and nonunions, metallic radial head arthroplasty has also shown promise in the treatment of elbows formerly treated with excision of the radial head (20).

As is the case for other joint replacement procedures, whenever there is a feasible chance that the native radial head can be preserved, radial head arthroplasty should not be performed. The use of ORIF for the treatment of reconstructible radial heads should not be ignored. Arthroplasty should be reserved for cases in which the radial head is not salvageable due to factors such as severe comminution or debilitating pain.

TECHNIQUE

Radial head arthroplasty can be performed through either a posterior or a lateral incision. A posterior incision affords access to both the medial and lateral side of the elbow depending on the surgical needs of the case. In addition, the posterior approach provides a cosmetically pleasing incision and results in the least cutaneous nerve disturbance. In contrast, the lateral approach provides a direct approach to the radial head with typically a smaller incision and potentially less surgical dissection. It does not afford the ability to approach the elbow medially if necessary through the same incision.

Deep surgical dissection can be facilitated through a number of muscular intervals. In cases with acute injuries, there may often be a violation of the lateral extensor muscle mass origin that can be developed to expose the radial head. Otherwise, there are three common intervals that can be utilized. Beginning from posterolateral to anterolateral, they include:

(1) The Kocher Approach
(2) The mid-Lateral Approach
(3) The Wagner Approach

The Kocher approach involves development of the interval between the Anconeus and Extensor Carpi Ulnaris. It inherently involves violation of the lateral ulnar collateral ligament complex and therefore requires a diligent repair with closure. The mid-lateral approach involves identifying the center of the radio-capitellar axis through the extensor origin and placing a full-thickness muscle-splitting incision down to the radio-capitellar joint. The interval can be increased by raising the origin of the extensor mass origin proximally along the supracondylar ridge of the lateral distal humerus. Posterior dissection of the distal humerus is avoided in order to spare the origin of the lateral ulnar collateral ligament complex. Lastly, the Wagner approach utilizes the interval between the Extensor Carpi Radialis / Brevis and the Extensor Digitorum Comminis. This approach provides an anterior approach to the radio-capitellar joint and also minimizes injury to the lateral ulnar collateral ligament (Fig. 5).

Once the radial head is exposed the specific surgical implant insertion techniques and instructions should be followed. As such, certain principles should be considered during the arthroplasty :

– The posterior interosseous nerve is at risk for iatrogenic injury. To avoid injury, retraction of tissue superior to the radial head and neck should be performed gently. Similarly, dissection beyond two centimeters distal to the radial neck should be avoided. Lastly, the forearm should be kept pronated to maximize the distance of the nerve from the surgical field.

– During excision of a fractured radial head, all fractured fragments should be removed and saved. If fragments or portions of the radial head remain attached to the shaft they should be removed sharply with an oscillating saw in order to avoid fracturing or destabilizing the remaining radial neck.

– When the radial head implant is being broached and sized, the anatomic goal should be to restore longitudinal length to the forearm so that normal proximal and distal radioulnar joint relationships are restored while not „over-stuffing“ the joint. Placing too large of an implant can result in elbow and wrist pain, increased capitellar wear, and decreased motion. With the implant or trial in place, range of motion of the elbow under direct visualization should demonstrate approximately 1 mm of space between the implant and capitellum through the range of motion.

– With the implant in place, the integrity of the lateral ulnar collateral ligament complex should be judged and repaired or reconstructed as needed.

OUTCOMES

The use of radial head arthroplasty has proven to be a successful means of treating complex, unstable radial head fractures not amenable to excision or ORIF. Overall, patients report subjectively favorable results, including good pain scores and functional range of motion. Recovery from radial head replacement generally occurs by six months (14). Grewal et al followed twenty-six patients who sustained comminuted fractures of the radial head for two years and found that overall patient satisfaction was high and that treatment with radial head arthroplasty is a safe, viable treatment option (14). Similarly, Shore et al demonstrated that radial head arthroplasty provides good range of motion and pain relief over a five to ten year period when used for the treatment of recalcitrant post-traumatic elbow disorders (40). Moro et al demonstrated the short term benefits of radial head arthroplasty for the treatment of severely comminuted radial head fractures (30). While some impediments to elbow mechanics were noted in this study, the overall judgement is that radial head arthroplasty is an effective treatment modality for irreparable fractures. Similarly, Ashwood et al showed in their review of patients treated with radial head arthroplasty that replacement of the radial head should be accompanied by early range of motion and exercise in order to achieve optimal results (1).

Despite the overall success of radial head arthroplasty, well-documented complications have been reported. Some of the more frequently encountered problems in radial head arthroplasty include stiffness, osteoarthritis, posterior interosseous nerve injury and implant failure.

Stiffness accounts for a large fraction of the postoperative morbidity observed. Stiffness can be caused for a variety of reasons. These include capsular contracture, heterotopic ossification or retained fragments within

the joint space (21, 22, 34). Contractures and limited range of motion can improve dramatically with stretching exercises and physical therapy. Specific limitations, such as loss of flexion and extension, respond to measures such as turnbuckle splinting (13). Patients who fail nonsurgical management can be treated with capsular releases. Contracture caused by heterotopic ossification can be treated by local excision and a one-time dose of 500 cGy radiation therapy or indomethacin to prevent recurrence.

Injury to the posterior interosseous nerve can occur with dissections distal to the radial tuberosity and with unscrupulous placement of retractors around the radial neck (29, 44). It has been suggested that this injury can be avoided by pronation of the forearm during surgical exposure, which increases the distance between the surgical field and the nerve itself, thus mitigating the risk of injury (7). Another important surgical hazard to consider is potential damage to the ulnar lateral collateral ligament, an important posterolateral stabilizer. This ligament should be preserved and if damaged during the exposure, be repaired (10, 32, 33).

Implant failure is a potential complication of radial head arthroplasty for several reasons. Aseptic loosening can occur leading to symptomatic instability or poor range of motion with the use of several designs (26, 43). Another technical downfall leading to implant failure is the so-called „overstuffing“ of the joint due to improper over-sizing of the prosthesis and subsequent erosion of the capitellar surface (see figure 5). This may be avoided by taking preoperative radiographs of the opposite elbow in order to better judge the size of the native radial head (8).

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