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SURGICAL MANAGEMENT OF RADIAL HEAD FRACTURES

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Fracture of the radial head is the most common skeletal injury in the adult elbow. Most radial head fractures occur in those who are between 20 and 60 years of age. The most common mechanism of injury involves a fall on the outstretched hand with the forearm pronated and the elbow partially flexed. The anterolateral one third of the head surface lacks thick articular cartilage and strong subchondral support, making this region more susceptible to fracture.[1]

The radiocapitellar joint functions in load bearing, supporting up to 90% body weight during certain activities.[2] The radial head also acts as a secondary stabilizer of the medial collateral ligament when there is valgus stress and functions with the coronoid to provide the elbow with an anterior buttress. [3-6] With loss of the bony integrity of the radial head and additional ligamentous support following trauma, the elbow is rendered unstable.

Most fractures of the radial head involve a component of articular impaction in addition to shear. The simplest pattern of displacement involves failure of a margin of the head in compression. Higher-energy injuries involving the radial neck often occur in the setting of associated failure of the soft tissues of the elbow and/or forearm. A common injury pattern involves a radial head fracture, coronoid fracture, and elbow dislocation (the "terrible triad") with collateral ligament disruption.[7] Elbow dislocation is seen in up to 10% of radial head fractures; conversely, radial head fractures are reported as occurring in 5% to 10% of elbow dislocations.[8, 9] The load-bearing function of the radial head becomes increasingly important as more supporting structures are compromised. In the face of elbow dislocation, fractures affecting greater than about 30% to 40% of the radial head should be fixed to restore lateral elbow support and elbow joint stability.[10]

1 Imaging and Indications for Operative Management

True radiographs of the radial head must be centered and perpendicular to its surface; however, the cylindrical shape of the head often makes it difficult to accurately determine the amount of joint involvement and the degree of displacement using standard films. In many instances, oblique views and specialized images such as the radial head–capitellum view designed to better image the radial head are helpful.[11] Computed tomography can be beneficial in some injuries to better characterize the fracture and plan for operative intervention (Figure 1).

The most common classification system for radial head fractures is that of Mason, which has been progressively modified since its original description.[12,13] Type I fractures are those with no mechanical block to motion and less than 2 mm of intra-articular displacement. These are treated with a brief period of immobilization followed by aggressive range of motion. Type II fractures have >2 mm displacement, or mechanical block to motion, but without significant comminution. Open reduction and internal fixation is usually indicated for these fractures. Type III fractures have severe comminution and are not amenable to open reduction with internal fixation, thus requiring either excision or replacement. The most critical point to consider when evaluating these Type III injuries is whether the radial head is an isolated injury or is combined with other bony or ligamentous injuries, as these factors will greatly influence treatment. Johnston noted the importance of this distinction by considering Type IV fractures to be those that occur with an ulnohumeral dislocation.[12] The decision whether to excise or replace the radial head is a critical one and will be addressed below.

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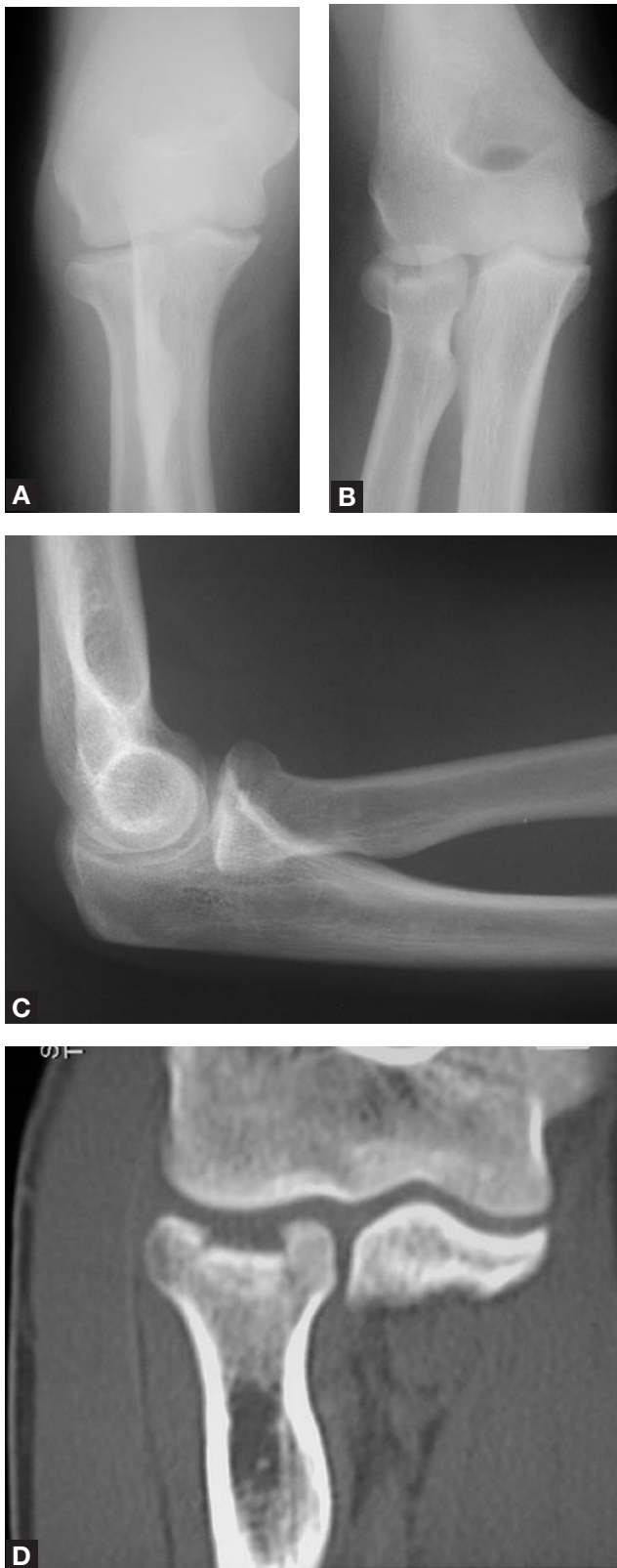
Figure 1. (A) Anteroposterior, **(B)** oblique, and **(C)** lateral radiographs of a radial head fracture. Note how benign the fracture appears on the frontal and lateral images. **(D)** Computerized tomographic section depicting significant central articular impaction. Articular involvement and displacement are often difficult to assess on plain radiographs because of the spherical nature of the radial head. Occasionally, special imaging studies are required to accurately define joint involvement.

Methods of Internal Fixation

Internal fixation of the radial head is technically demanding, owing to the small and often comminuted nature of the fragments as well as the circumferential articular cartilage on the head. For more simple fracture patterns involving impaction of a portion of the head, a limited approach can be effective. It must be noted that the traditional Kocher interval (extensor carpi ulnaris-anconeous interval) is well posterior to the axis of the radial head. A much easier deep approach involves a full-thickness incision in the central aspect of the common extensor origin at the midline of the radiocapitellar joint.[10] The tendon origin is slit with the annular ligament and joint capsule, which are not identifiable as separate structures surgically (Figure 2).

Once the joint hematoma is evacuated and the fracture identified, care is taken to remove any osteochondral fragments within the fracture or the joint. These can be off of the radial head or the capitellum. Impacted or centrally depressed fragments are elevated with fine instruments. A tamp is often helpful to elevate depressed rim fragments, which commonly contain an intact periosteal sleeve. Once the fracture is reduced, provisional Kirschner-wire fixation is helpful. Care must be taken not to have the wires converge, in order to allow for adequate screw purchase within the head. When the fracture involves only a segment of the radial head, the wires are replaced with small compression screws for definitive fixation. Two-millimeter and occasionally 1.5-mm implants are most commonly used. Care must be taken not to penetrate the opposite cortex, and the screw heads are countersunk beneath the articular surface[1, 10] (Figure 2).

When comminution extends down the radial neck, small 2.0-mm and 2.4-mm plates are most commonly utilized to stabilize the radial head. Exposure of the radial neck requires retraction of the supinator, which is elevated from posterior to anterior with the forearm in pronation protecting the radial nerve[10, 14] (Figure 3). In reality, exposure can proceed to the midline of the radial tuberosity without putting the nerve in direct jeopardy.[15] When used, plates must be applied in the "safe zone" of the radial head that does not articulate with the sigmoid notch of the proximal ulna, defined as the quadrant located laterally with the forearm in neutral rotation or posteriorly in supination.[16] Even if placed appropriately, plates may impinge on the overlying soft tissues and limit the recovery of forearm rotation (Figure 3).

Autogenous bone graft is often required to support depressed articular fragments or replace comminuted defects of the radial neck. The graft can be obtained from the iliac crest or locally from the olecranon process of the proximal ulna or the distal radius.[17] Closure involves repair of the common extensor origin containing the annular ligament on its undersurface. If the tendon and ligament origin has been torn off of the humeral epicondyle, this is repaired back to bone.
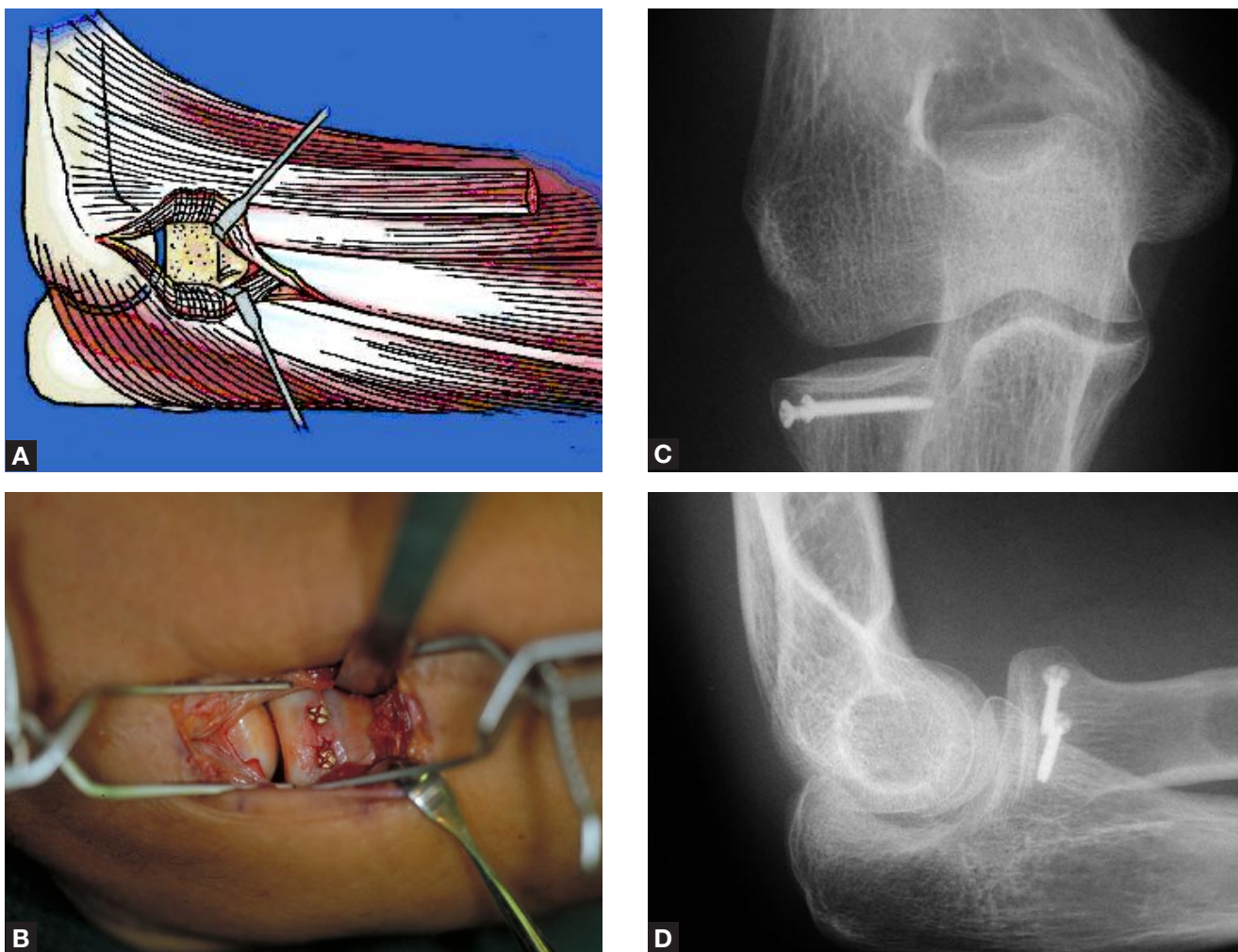
Figure 2. (A) Diagram illustrating exposure of the radial head by a single incision through the extensor tendon, annular, and collateral ligament complex at the midline of the radial head. This is the easiest deep approach to access the radial head without compromising lateral joint stability. **(B)** Surgical exposure used to repair a radial head shear fracture. Note the parallel 2.0-mm screws that are countersunk beneath the articular surface. **(C)** Anteroposterior and **(D)** lateral radiographs depicting fracture fixation. (Figure 2A courtesy of Hill Hastings II, MD)

3 Excision Versus Arthroplasty

When radial head fractures are too comminuted to allow for stable internal fixation, a decision must be made whether to excise or replace the head. When the ligaments are intact, resection will not result in motion loss, but it will lead to weakness in grip and forearm loading. In fractures with associated elbow joint dislocation or forearm interosseous ligament failure,[18,19] resection is contraindicated.[20] In this setting, implants are required to restore the valgus and axial load-bearing functions of the radial head and allow proper healing of the soft tissues without proximal migration of the radius. Most irreparable displaced and comminuted radial head fractures are seen in these higher-energy injuries. Thus the morphology of the radial head fracture is valuable in predicting the stability of the elbow.[21]

Silicone prostheses are no longer recommended as replacements to the radial head following trauma. They lack the necessary biomechanical support for the elbow joint.[3, 22-24]

Newer metallic radial head implants have been shown to better restore valgus stability to the elbow and are now available in monopolar and bipolar designs (Figure 4).[24-26] The bipolar implants have the theoretical advantage of more uniform stress transfer to the capitellum. No matter which implants are chosen, repair of the lateral (and occasionally medial) soft tissue structures at the epicondyles is required to restore stability to the elbow.[20] This is most effectively performed with transosseous sutures tied along the lateral humeral column.

4 Rehabilitation

After surgery on the radial head, a program of relatively early motion is typically begun. Elbow extension tends to be the most difficult to recover, followed by forearm supination. A nighttime resting long arm splint in maximum extension (which is gradually straightened as motion returns) is often helpful to decrease elbow flexion
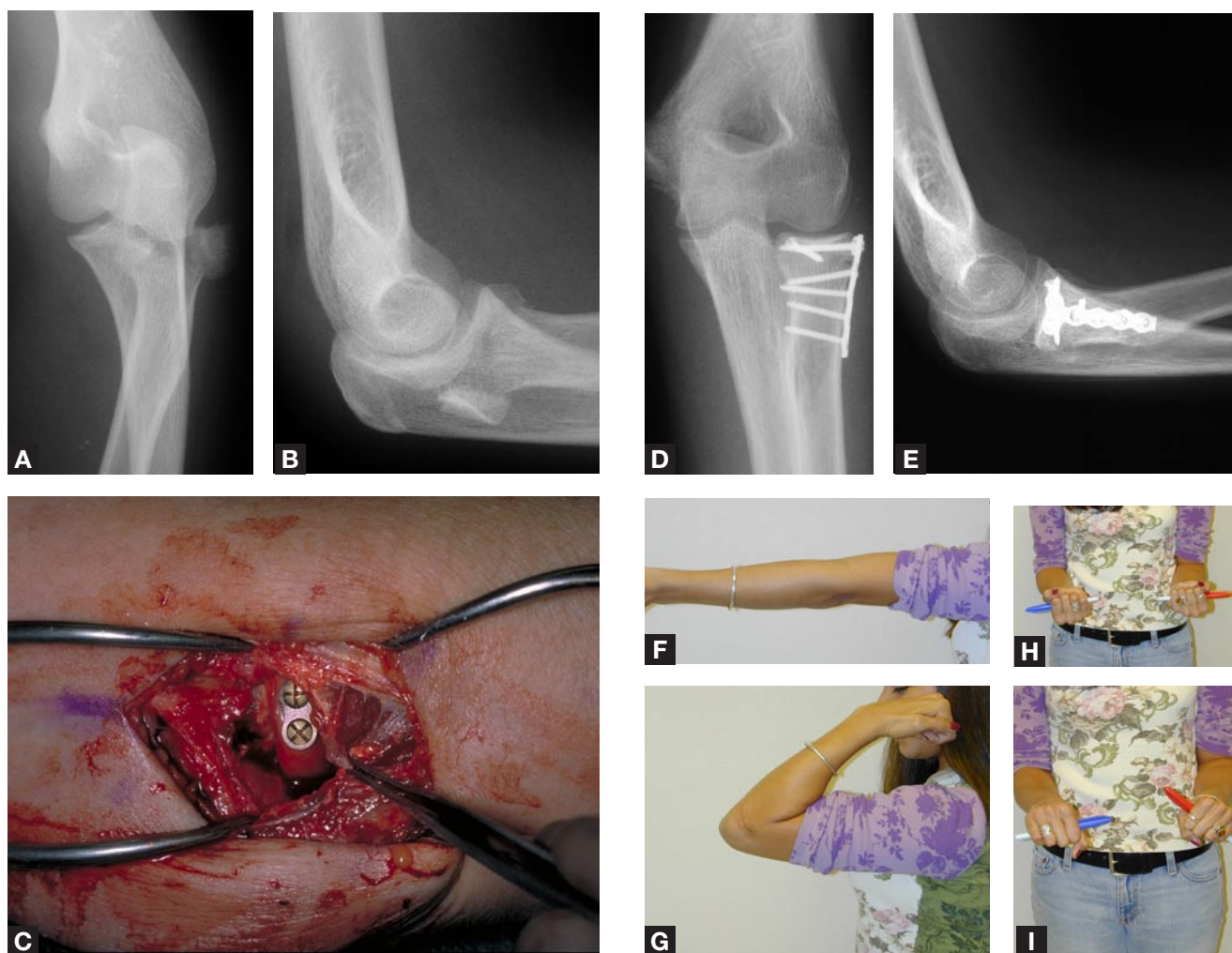
Figure 3. (A) Anteroposterior and (B) lateral radiographs of severe radial head and neck fracture in a female 16-year-old. (C) Intraoperative photograph with plate applied. The pick-up is on the posterior border of the supinator, which has been reflected from posterior to anterior to expose the radial neck, thereby protecting the posterior interosseous nerve. (D) Anteroposterior and (E) lateral postoperative radiographs. (F) Final clinical result in extension, (G) flexion, (H) supination, and (I) pronation. Note the loss of terminal rotation, which is not uncommon when plates are applied to the radial head and neck.

contractures. Static progressive splinting, using the principles of passive progressive stretch of the soft tissues, is effective once adequate bony and soft-tissue healing has occurred.

In more severe trauma with extensive soft-tissue injury, especially in the setting of associated head trauma, heterotopic ossification prophylaxis should be considered. A single dose of limited field radiation (600–700 rads) or, for a short-term, nonsteroidal anti-inflammatory medication can be used. Heterotopic ossification is not well understood, but it is related to the severity of the original injury. Repeated surgical procedures and a delay in surgical intervention may be risk factors as well.

5 Complications

Loss of motion (posttraumatic stiffness) is the most common complication following radial head fracture, especially when plates are used for internal fixation of comminuted Mason Type III fractures. This is most likely related to the associated soft-tissue injury about the elbow and/or impingement from the hardware limiting rotation. When all

conservative measures have failed and significant motion loss remains, surgical release of the elbow joint can be considered. If motion is limited by heterotopic bone, this can be safely excised as early as 3 to 6 months once sharp cortical margins of the ectopic bone are identified. Hardware can be removed at this time as well if it is considered to be a factor in motion loss.

Loss of fixation is not uncommon following internal fixation of radial head fractures, especially those with 3 or more fragments. Unrecognized comminution, poor bone stock, poor surgical technique, and non-compliance on the part of patients can contribute. Unfortunately, revision internal fixation is most commonly not possible, and excision or replacement must be chosen in this setting.

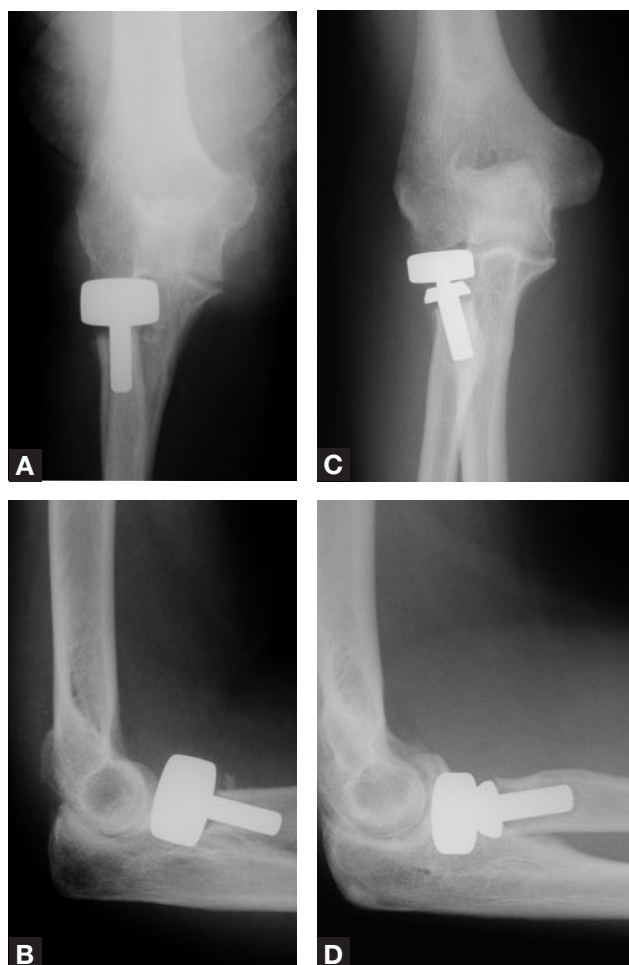### AUTHORS' DISCLOSURE STATEMENT AND ACKNOWLEDGMENTS

Figure 4. (A) Anteroposterior and **(B)** lateral radiographs of a monopolar metallic radial head implant. **(C)** Anteroposterior and **(D)** lateral radiographs of a bipolar metallic implant.

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