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RADIAL HEAD FRACTURES, EPIDEMIOLOGY, ANATOMY, MECHANISM OF INJURY, CLASSIFICATION, IMAGING PRESENTATION, CLINICAL PRESENTATION, MANAGEMENT AND COMPLICATIONS

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SUMMARY

Introduction: *In recent years the understanding and comprehension of the elbow has improved, clarifying some aspects of the complex diarthrodial joint. The relevance of the radial head in the biomechanics of the elbow is recognized which helps to improve the management and treatment of fractures at this site. Elbow trauma is the most common origin of proximal radius fractures, this trauma can be direct or indirect and can cause an isolated fracture, a fracture associated with other fractures and ligament injuries.*

Objective: *to detail the current information related to radial head fractures, epidemiology, anatomy, presentation, clinical evaluation, imaging evaluation, classification, treatment and complications.*

Methodology: *a total of 42 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 31 bibliographies were used because the other articles were not relevant to this study. The sources of information were PubMed, Google Scholar and Cochrane; the terms used to search for information in Spanish, Portuguese and English were: radial head fractures, radial head prosthesis, radial head arthroplasty.*

Results: *Radial head fractures have an incidence of 2.5 per 10,000 per year, which represents 1.7 to 5.4% of all fractures. Most radial head injuries are the result of a fall on the hand in extension. Usually the affected individuals show limitation of mobility of the forearm and elbow in addition to pain or discomfort when making passive rotational movement of the forearm; they also usually present pain on palpation over the radial head and joint effusion in the elbow. Sometimes there is a fracture-dislocation of the radial head related to a rupture of the interosseous membrane with lesion of the distal radioulnar joint called Essex-Lopresti lesion.*

Conclusions: *The radial head together with the interosseous membrane of the forearm provide longitudinal stability; when the interosseous membrane is damaged, a proximal migration of the radial head may occur after removal of the radial head. When presenting clinical suspicion of elbow fracture, standard anteroposterior and lateral projections of the elbow should be requested, as well as oblique projections such as the Greenspan projection.*

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The Manson, Mason-Johnston or Mason classification modified by Hotchkiss is usually used for classification. Among the indications for conservative treatment are solitary, undisplaced or minimally displaced fractures that do not present mechanical blockages in the range of motion or less than 3 mm of displacement. Studies report the effectiveness of open reduction and internal fixation of simple Mason type II fractures; Manson type III fractures are controversial.

Complications usually arise from contracture subsequent to prolonged immobilization or secondary to persistent pain, edema and swelling; which may be due to undiagnosed osteochondral injury of the capitellum.

KEY WORDS: *fracture, radius, head, prosthesis, elbow.*

INTRODUCTION

In recent years, the understanding and comprehension of the elbow has improved, clarifying some aspects of the complex diarthrodial joint. The relevance of the radial head in the biomechanics of the elbow is recognized which helps to improve the management and treatment of fractures at this site. Elbow trauma is the most common origin of proximal radius fractures, this trauma can be direct or indirect and can cause an isolated fracture, a fracture associated with other fractures and ligament injuries. Radial head fractures can be divided into several types, the most common being the Manson classification. Type I fractures are managed conservatively. Treatment of type II and III injuries is still controversial, so more evidence and testing is needed in these areas. Radial head injuries can range from solitary insignificantly displaced fractures caused by low energy impacts to impacted comminuted fractures caused by high energy mechanisms accompanied by ligament and bone injury. The most common complication of radial head fractures is stiffness. It is important to take into account some factors to decide the treatment of these fractures, such as: the stability of the elbow, the ability to achieve a successful reconstruction and the presence of associated injuries(1-7).

METHODOLOGY

A total of 42 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 31 bibliographies were used because the information collected was not important enough to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar; the terms used to search for information in Spanish, Portuguese and English were: radial head fractures, radial head prosthesis, radial head arthroplasty.

The choice of bibliography exposes elements related to radial head fractures, epidemiology, anatomy, presentation, clinical evaluation, imaging evaluation, classification, treatment and complications.

DEVELOPMENT

Epidemiology.

Fractures of the radial head have an incidence of 2.5 per 10,000 per year, which represents 1.7 to 5.4% of all fractures, being approximately one third of elbow fractures. The injury occurs mostly in women and in middle-aged patients, the average age being 45 years. Fractures of the head and neck of the radius in children have an incidence of up to 14% of all elbow fractures, becoming a complicated challenge in the pediatric patient. One third of affected individuals show associated injuries, such as a fracture or ligament injury of the shoulder, arm, forearm, wrist or hand; these usually dictate the treatment. The origin of radial head fractures is frequently from a fall on the outstretched hand(1,8-13).

Anatomy

The radial head articulates with the capitellum and the proximal ulna; some anatomical studies of the radial head show that the head is not circular and maintains a relative displacement. The total rotation of the radial head will depend on it being in a physiological location within the lesser sigmoid notch. The radial head has a fundamental role in the valgus stability of the elbow, however the degree to which it generates this stability is still under debate. The radial part of the radiocapitellar joint is lined by articular cartilage, the 280 degrees of the rim of the head is lined by thick hyaline cartilage in addition to articulating with the sigmoid notch. The blood supply to the radial head is poor, with only a single extraosseous vessel penetrating most of the time. The physiological range of motion of the elbow is 75 degrees of supination, 0 to 150 degrees of flexion and extension and 85 degrees of pronation.

The radial head is a secondary restrictor of the valgus forces and probably its mechanism is displacing the varus-valgus rotation center, reducing the moment of force generated in the medial ligament. After a lesion of the medial collateral ligament, the radial head becomes the primary stabilizer against compressive and valgus forces, therefore, when there is an alteration in this ligament added to the removal of the radial head, valgus instability will increase even more. Radial head arthroplasty is optimal to reestablish stability in these cases. The integrity of the radial head has greater relevance in an injury of the ligaments and musculotendinous units near the elbow. The radial head together with the interosseous membrane of the forearm provide longitudinal stability; when the interosseous membrane is damaged, after removing the radial head, a proximal migration of the radius may occur(1,2,5,8,9,14-18).

Mechanism of Injury

Most radial head injuries are the result of a fall on the hand in extension. High-energy injuries are generated by a fall from a certain height or while playing sports. The radial head fractures upon impact with the condyle. This can happen with a posterolateral rotational force, with a net axial load or by generating a posterior dislocation of the radial head in addition to

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a Monteggia fracture-dislocation or a fracture-dislocation of the olecranon. It is usually related to injuries of the elbow ligaments and less usual is its association with fractures of the condyle(8,9).

CLINICAL EVALUATION.

Affected individuals usually show limited mobility of the forearm and elbow as well as pain or discomfort on passive rotation of the forearm; they also usually have pain on palpation over the radial head and joint effusion at the elbow. It is essential to perform an exploration of the distal part of the forearm and wrist on the same side. Sometimes there is a fracture-luxation of the radial head related to a rupture of the interosseous membrane with lesion of the distal radioulnar joint called Essex-Lopresti lesion, this can be inferred by pain when performing movements that force the distal radioulnar joint, or pain on palpation. A valgus instability can be generated with the lesion of the medial collateral ligament, so it should be evaluated, mostly in cases of type IV fractures of the radial head of the radius. Drainage of the hemarthros by a direct lateral approach complemented with injection of a local anesthetic significantly reduces pain, in addition to allowing examination of the range of passive mobility, identifying if there is any degree of mechanical blockage. The severity of radial head fractures is directly related to the occurrence of associated injuries, these usually present various patterns, among which can be divided into the following:

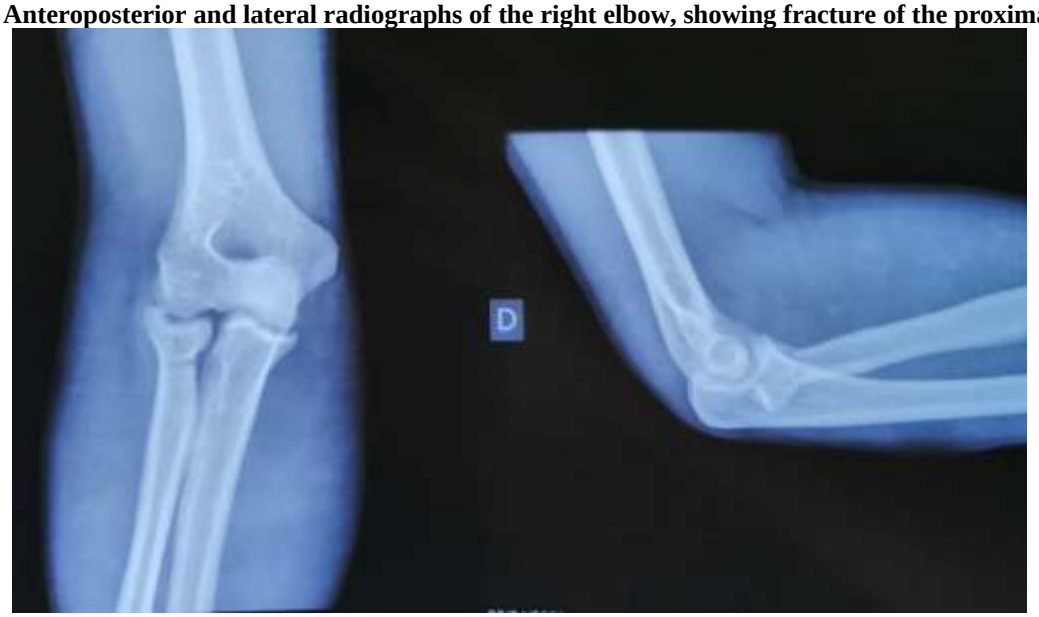
- Radial head fracture and rupture of the interosseous ligament of the forearm.
- Fracture of the radial head and rupture of the medial collateral ligament or capitellar fracture.
- Radial head fracture and posterior dislocation of the elbow.
- Terrible triad: posterior elbow dislocation with fractures of the radial head and coronoid process.
- Fractures posterior dislocations of the olecranon.

Approximately 10% of individuals with a radial head fracture also present fractures of the hand, wrist and scaphoid(3,8,9,19-21).

Imaging Evaluation.

When presenting clinical suspicion of elbow fracture, standard anteroposterior and lateral projections of the elbow should be requested, in addition to complement the oblique projections such as the Greenspan projection, the latter will show more accurately the fracture in case of fracture doubt not evidenced in the first projections, since it allows to observe in a better way the condyle-radial joint; The Greenspan projection is made by placing the forearm in neutral rotation and the beam of rays angled 45° in cephalic direction; this projection. When there is wrist pain and comminuted fractures, it is recommended to order radiographs for comparison. Non-displaced fractures are often difficult to diagnose, however they can be suggested by the positive fat pad sign in the lateral projection. To better visualize the fracture and to plan surgical resolution, it is sometimes necessary to perform a CT scan of the elbow, primarily when there is comminution or displacement of the fragments. Magnetic resonance imaging (MRI) is usually not necessary, however, it assesses soft tissue injuries related to radial head fractures(2,3,8,9).

Figure 1. Anteroposterior and lateral radiographs of the right elbow, showing fracture of the proximal radius.



Source: the authors.

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Classification.
Mason's classification.
Type I: non-displaced fractures, non-displaced marginal or intra-articular displacement <2 mm. No mechanical block of pronation.
Type II: Displaced marginal fractures or intra-articular displacement >2 mm whether impacted, depressed or angulated. May be accompanied by movement block or incongruence.
Type III: comminuted fractures, affecting the entire radial head. It is considered non-repairable due to its radiographic or intraoperative appearance.
Type IV: fractures related to a dislocation of the elbow "Johnston".
There are other types of classifications such as those of the AO, Condict Cutler, Manson's classification which divided into 3 types, Mason-Johnston's classification which adds type 4 and the Mason's classification modified by Hotchkiss which better defines the need for surgical treatment(1,8,10).

Treatment.
Some aspects present great relevance at the moment of choosing the best treatment strategy, among which we have:

- Joint involvement.
- Displacement.
- Fracture stability.
- Presence of associated injuries in the forearm or elbow.
- Some of the treatment objectives are:
- Achieve stability of the forearm and elbow.
- Correct any blockage of forearm rotation.
- Obtain early range of motion of the elbow and forearm.
- Decrease the likelihood of humero-ulnar osteoarthritis.
- Decrease the probability of radial condyle arthrosis.

The therapeutic decision based on the classification serves as a guide and not as a strict law. Some factors not taken into account in current classification systems are:

- Joint impaction.
- Osteopenia.
- Radiocapitellar malalignment.
- Metaphyseal bone loss(3,8).

Conservative Treatment.
Most solitary fractures of the radial head can be managed conservatively. Indications include solitary, undisplaced or minimally displaced fractures with no mechanical blockage in range of motion or less than 3 mm of displacement. Consideration should be given to fracture stability, maintenance of forearm rotation and radiocapitellar alignment. Generally, conservative treatment involves immobilization time, use of a sling and then an increase in range of motion, generally recommended at 24 to 48 hours after the injury or according to pain. There are studies that recommend the use of an arthrocentesis of the radial condyle joint, with or without application of local anesthesia to reduce pain. If the pain is maintained, it suggests complementary examinations such as a magnetic resonance that can evidence a contracture and inflammation suggesting a fracture of the capitulum. Conservative management usually presents good evolution in up to 80% of the cases. Simple fractures with displacement between 2 and 5 mm can be treated conservatively or with internal fixation(3,8,9,22-25).
Surgical treatment.
The orthopedist should evaluate the aspects of the fracture, such as comminution, stability, joint depression and associated injuries for decision making.
Among the most viable alternatives for surgical resolution are:

- Excision.
- Internal fixation.
- Excision and arthroplasty.

Surgical treatment is only indicated in a displaced partial fracture of the Mason II radial head when there is blockage of mobility, which can be evaluated by placing local anesthesia with lidocaine in the elbow joint. A relative indication is a fragment larger than 2 mm that does not disrupt motion. A Kocher approach is usually performed to land just above the radial head; if possible, the uninjured lateral collateral ligament complex should be preserved. For surgical management, the lateral approach is mostly used, making an incision over the lateral epicondyle and running from the lateral aspect of the humerus to the proximal end of the radius. The Kocher interval between the extensor carpi ulnaris and anconeus is frequently used and can be extended if required. The pronated forearm protects the posterior interosseous nerve. In addition, care should be taken not to injure the lateral ulnar collateral ligament as this can destabilize the elbow. Another approach used is that of Kaplan, which uses the interval between the extensor digitorum communis and the extensor carpi radialis brevis, being more anterior it does not interrupt the lateral ulnar collateral ligament. Hotchkiss showed the division of the extensor digitorum communis being the anterior approach to the lateral ulnar collateral ligament complex. When posterior or medial exposure is needed, consideration should be given to using a posterior midline cut followed by full-thickness flap elevation medially and laterally. Another option is resection of the comminuted radial head to access a coronoid fracture. If necessary, separate accesses can be made(3,8,26-28).

When there is a complex injury, the pieces of the radial head may be displaced, with minimal or no soft tissue insertion and instability, for which an open reduction with internal fixation is usually performed with the intention of providing a stable and reliable fixation, generally in simple patterns, the ideal would be to provide a stable and rigid fixation of the articular surface, besides reestablishing the normal alignment of the radial head and neck, as well as reestablishing the articular congruences. An alternative for temporary reduction of simple partial joint fractures are K-wires or fracture reduction clamps. When an unstable elbow or forearm injury occurs, it is sometimes better to remove the remnants of the radial head and replace it with a metal prosthesis. For some comminuted fractures of complicated reduction, the "on table" reconstruction technique can be tried,

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which consists of the removal of the comminuted fragments for reconstruction on a table, outside the individual undergoing surgery, for subsequent reinsertion and fixation to the neck(3,8,29).

When a fracture-dislocation of the forearm or elbow plus a total fracture of the radial head and/or neck occurs, the possibility of an open reduction with internal fixation is usually kept open when a stable and reliable fixation is achieved, otherwise it is better to opt for radial head arthroplasty. Removal of the radial head in these individuals often results in instability. There are several models of prostheses on the market with differences in their stems and heads.

- There are stems: cemented, loose and press-fitted,
- There are metal heads: anatomical, circular monopolar and circular bipolar. Bipolar prostheses are cemented in the radial neck.

Radial head replacement has been associated with a higher rate of patient satisfaction, lower complication rate and better outcome than open reduction with internal fixation(3,8,13,30).

The ideal fracture to perform an open reduction with internal fixation is one that has 3 or less articular fragments, with absence of impaction and deformity, with pieces of sufficient size and bone quality to place the screws, besides having no or minimal metaphyseal bone loss. After the reconstruction with screws, the head of the radius is fixed to the neck of the radius with a plate in the posterior region so as not to limit the rotation of the forearm(8,9).

Figure 2. Radial head prosthesis implant.

Source: The Authors.

The theoretical rationale for a prosthetic replacement is to use it as a spacer trying to eliminate the risk of proximal migration of the radius. Both titanium and vitalium metal radial head implants are frequently used and are the implant of choice in unstable elbows; silicone implants some research suggests poor function. A problem in radial head arthroplasty is the placement of the appropriate size of the cephalic implant, which is sometimes larger than adequate. As for the removal of the radial head is rarely indicated, however it can be considered in isolated lesions in acute phase and is not recommended in the possibility of instability. It is recommended to use a direct lateral approach, being careful not to injure the posterior interosseous nerve, so sometimes it is suggested to perform a pronation of the forearm. The level of cut must be proximal to the annular ligament. When

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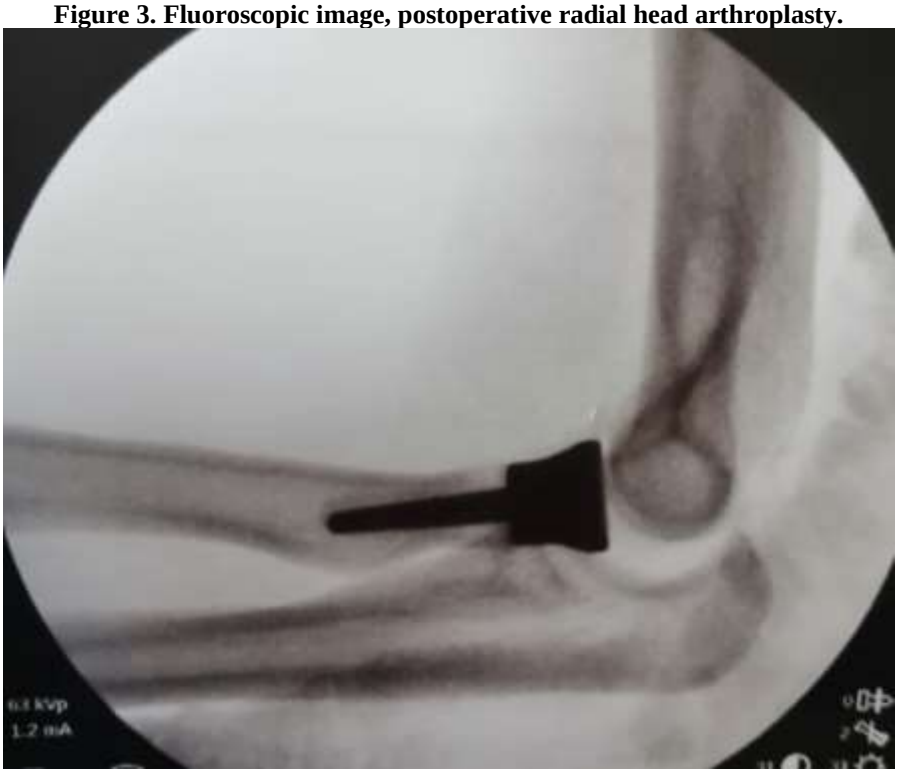
there is proximal migration of the radius with symptoms, a radioulnar synostosis is sometimes necessary. In Manson type II and III fractures, late excision usually provides good results. Contemporary evidence advocates open reduction and internal fixation in simple Mason type II fractures. Controversy still exists regarding the management of Mason type III fractures. In recent years, studies demonstrate the effectiveness of radial head replacement in almost all individuals with Mason type III fractures with 3 or more fracture fragments(3,8).

As previously mentioned the Essex-Lopresti injury is a longitudinal break of the interosseous membrane of the forearm, usually related to a fracture of the radial head and/or to dislocation related to injury of the distal radioulnar joint. The damage of the distal radioulnar joint is sometimes difficult to demonstrate, being pain its main characteristic, it is important to perform an assessment in lateral projection of the radioulnar joint, in addition to achieving the stability of the elements of the injury. When this lesion is present, at the moment of removing the head of the radius, a proximal migration of the radius may occur. Management is by repair or replacement of the radial head in addition to evaluation of the distal radioulnar joint.

In post-stable fixation care, it is essential to quickly begin active or active-assisted flexion-extension and pronation-supination exercises(8,9,21).

Figure 3. Fluoroscopic image, postoperative radial head arthroplasty.



Source: The Authors.

Complications

They are usually caused by contracture subsequent to prolonged immobilization or secondary to persistent pain, edema and inflammation; which may be due to an undiagnosed osteochondral lesion of the capitellum. After a short period of immobilization, pronation-supination and flexion-extension movements should be performed. With programmed and supervised physiotherapy there is evidence of a better response. Injury to the interosseous membrane, distal radioulnar joint or triangular fibrocartilage can trigger chronic pain. Post-traumatic radial condyle osteoarthritis may occasionally occur when there is joint incongruence or in case of free osteochondral fragments. Complex regional pain syndrome sometimes occurs after conservative or surgical management of radial head fractures and is usually associated with radial head injury. Occasionally, a hidden elbow fracture-dislocation may occur, leading to late dislocation due to the absence of treatment of the damaged ligaments(8,9).

Among the complications of radial head arthroplasty are the following:

- Radiocapitellar arthritis.
- Loosening of the stem.
- Failed components.
- Too large prosthesis(1,31).

CONCLUSIONS

Fractures of the radial head have an incidence of 2.5 per 10,000 per year, which represents 1.7 to 5.4% of all fractures. Most radial

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