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An Overview on Monteggia Fracture Diagnostic and Management Approach

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ABSTRACT

Fractures have been associated with a lot of consequences and complications affecting the daily lives of patients. Thus, much researchers have been done to know which fractures are associated with which complications. One of the most notable fractures is that of the forearm region, these have been noted to happen on many areas (proximal, distal, ulnar, and radial) due to the complexity of the area. One of the first descriptions of these injuries was by Dr. Giovanni Monteggia who identified shaft of ulnar fractures with dislocation of radial head pattern. Our objective was to look into the literature concerning Monteggia fracture and particularly the diagnosis process and management. PubMed database used for articles selection, papers on were obtained and reviewed. The forearm is one of the most important structures of the upper limb, thus any fractures and/or dislocations are clinically important. Monteggia fracture is one of the most common injuries of this are, and even though it can be easier to diagnose on radiologic studies it can be tricky to diagnose clinically. Most cases are treated surgically and will need a long rehabilitation course taking up to months. Nevertheless, many complications can occur in the pre-operative, post-operative, and even after rehabilitation.

Keywords: *Monteggia fracture, Management, Diagnosis, Clinical features*

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INTRODUCTION

Fractures have been associated with a lot of consequences and complications affecting the daily lives of patients. Thus, much researchers have been done to know which fractures are associated with which complications. One of the most notable fractures is that of the forearm region, these have been noted to happen on many areas (proximal, distal, ulnar, and radial) due to the complexity of the area. One of the first descriptions of these injuries was by Dr. Giovanni Monteggia who identified shaft of ulnar fractures with dislocation of radial head pattern back in 1814. Thus, this pattern of injury was eponymously named Monteggia fracture-dislocation-. Further researchers (like Jose Bado) made advancements in the management and introduced Monteggia lesion and Monteggia equivalent injuries. Moreover, recent advances in radiology, surgery techniques, and overall health care have helped in diagnosing, classifying, and choosing the best approach of treatment in these cases. However, recognizing and suspecting this fracture remains tricky in clinical practice and mistreatment may lead to complications (Monteggia, 1814; Bado, 1967; Rehim *et al*., 2014). In this paper, we will discuss the relevant anatomy, injury definition, diagnosis, and management of monteggia fracture.

MATERIALS AND METHODS

PubMed database was used for articles selection, and the following keys were used in the mesh ((Monteggia fracture) AND (management)) OR (Diagnosis)). The articles chosen for inclusion were based on meeting one or more of the following criteria: Monteggia fracture or its risk factors, evaluation process, diagnosis, and/or management. All other articles that

did not match the requirements inclusion criterion were excluded.

Review

The forearm is an important structure in the body and arm due to its major role in daily activities. This is due to the major flexibility it offers with pronation and supination move for the hand, sharing the loading stress among the –forearm- bones, and as an attachment site for muscles. The anatomical structure of this unit is constituted of two bones, interosseous membrane –IOM-, a functional joint (middle radioulnar joint –MRUJ- formed by the bones of the forearm and the IOM), and 2 –anatomical- joints (distal radioulnar joint -DRUJ- and proximal radioulnar joint –PRUJ-). These joints are considered the lockers of the area allowing stable pronation and supination, along with interosseous membrane which shifts the load between the bones (usually from radial to ulnar bone). Pronation and supination actions happen with rotation of the radiocapitellar joint (proximal radial head articulation with the capitulum of the humerus) within the annular ligament. At the proximal level, the ulnar bone consists of the olecranon and coronoid. When we move distally, the ulnar head is a part of the triangular fibrocartilage complex (TFCC) at the wrist and the radial head connects with the wrist at the level of scaphoid and lunate bones. Overall, primary stabilization of the proximal forearm is via the radiocapitellar joint, and the distal one is via the triangular fibrocartilage complex, while IOM distributes the load (ElKhouly *et al*., 2018; Siebenlist *et al*., 2019). Interosseous membrane is easily injured in fractures, due to its various structures. It includes five ligaments; central band, proximal oblique cord, accessory band, distal oblique bundle, and dorsal oblique accessory cord. The main ligament is the central one which is the thickest and wide between the five and has an oblique angle between the 2 main bones. Accessory ligaments run in the same direction, and both of them form the middle ligamentous complex. The other structures are not constant between individuals anatomically speaking. Nevertheless, most of the time the distal portion of the interosseous membrane can be a secondary stabilizer of the area when the distal radioulnar joint is compromised. In clinical practice, the injuries to the 3 lockers are important to distinguish. This is due to different stabilization positions, while PRUJ and MRUJ are critical for rotational stability, IOM is vital for longitudinal static stability. Moreover, injury to only one of the lockers the other can compensate to preserve the longitudinal stability, however, when two or three are injured compensation is absent and instability occurs (Noda *et al*., 2009; Soubeyrand *et al*., 2011; Dumontier & Soubeyrand, 2014).

Monteggia fracture defines as a dislocation of the radial head –PRUJ- (with IOM rupture) due to ulnar bone shaft fracture. This two lockers fracture is one of the most common fracture-dislocations of the forearm. Usually, the distal part of the shaft is more commonly fractured than the midshaft ones (Artiaco *et al*., 2020).

Etiology and risk factors

The most common mechanism of injury in this entity of fracture is by a direct hit to the forearm while the elbow is extended, and the forearm is in hyperpronation. This usually results in a major load on the IOM which tries to shift through it, but usually will lead to rupture of the annular, and proximal quadrate ligaments. This will eventually lead to disruption of the radiocapitellar joint and thus a radial head dislocation (Calderazzi *et al*., 2018). Thus, from this mechanism, it is easy to recognize the risk factors and usual mechanism of injury. Motor vehicle accidents, falling from heights, and sports injuries are commonly seen in the younger population and they are due to high energy trauma. On the other hand, low-energy trauma with minimal triggers such as ground-level falls is more commonly seen in the elderly. Thus, risk factors include athletes (especially in full-contact sports like American football and wrestling), post-menopausal women, and osteoporosis (Papaioannou *et al*., 2018).

Clinical features

Patients usually present to ER with pain at the site of injury. The clinician shall be very careful with these injuries and perform a detailed history taking and physical examination. A full inquiry about the mechanism of injury is vital to determine the risk of other injuries and complications. The previous history of fractures may indicate underlying osteoporosis. Patients shall be asked about any signs of nerve damage; including numbness, paresthesias, weakness in muscles, and radiating pain. Starting with inspection, full attention to skin, soft tissue, and any visible body deformities is a must. Moreover, lacerations, muscle contusions, neurovascular deficits, and tendon damage. Any open wounds over the fracture site are very risky and should not be probed. These may indicate an open fracture that requires direct urgent surgery. Furthermore, palpation shall be done to identify any focal tenderness and deformities. Physicians shall keep an eye on any concomitant injuries and examine the whole arm. All patients should undergo a neurological examination of median and radial nerves, even though they are not commonly injured. A detailed neurovascular examination is also a must in high energy crush injuries with repeating it at certain intervals to rule out any possible acute compartment syndrome (Rehim *et al*., 2014; Calderazzi *et al*., 2018; Jungbluth *et al*., 2018)

Diagnosis

After clinical suspicion is raised, patients shall immediately be sent for radiography. X-ray views taken are usually in the anteroposterior and lateral view which are the most helpful in diagnosing the fracture. However, an oblique view will help to confirm the classification of this injury. Routinely, further wrist and elbow radiographs are obtained to identify any coexisting injuries. Some differential diagnoses to keep in mind for this injury include; elbow dislocation, fracture, wrist dislocation, and fracture. Further imaging is not usually needed, however, computed tomography (CT) can be used pre-operative for assessment of non-union. Moreover, magnetic resonance imaging (MRI) can be done to evaluate any possible interosseous membrane disruption and TFCC tears (Ozel & Demircay, 2016; Calderazzi *et al*., 2018; Jungbluth *et al*., 2018).

Monteggia lesions and their classification was developed by Bado in the late sixties with four main types based on radiological findings. These types have been implemented to guide the expected outcome of these patients and ease the diagnosis process and management overall. The main differentiation point of these types is based on the radial head dislocation direction. Type I is when the proximal ulna is fractured and the radial head is dislocated anteriorly. This type is the most common type seen clinically in children, and the

classical mechanism of injury mentioned earlier causes it. Another mechanism is when the contracted biceps resists the extension of the forearm leading to dislocation then the impact leads to fracture. Type II, defined by posterior fracture of the ulnar shaft and posterior radial head dislocation. It is most typically seen in adults and usually caused by axial pressure against the forearm with slight flexion of the elbow. Unfortunately, this type is associated with higher rates of radial head fractures, posterior interosseous nerve injury, and instability of the ulnohumeral joint. Recently, Jupiter and colleagues further expanded on this type and added four additional subtypes (from A to D) based on the ulna fracture location, type, and the exact radial head injury. These subtypes have associated any olecranon fractures with worse outcomes. Type III is when both the ulna fracture and radial head dislocation are going laterally. This happened mostly in children due to varus pressure on an extended elbow which results in a greenstick fracture (of the ulna). Type IV is when both the ulnar and radial shafts are broken with an anterior radial head dislocation. This is the rarest and the least understood injury among the types. These injuries, especially radial head dislocations are easily missed since the ulnar shaft is distracting. A pattern of identifying these injuries is by drawing a line through the radial shaft and head. If this line does not pass through the middle third of the capitellum then a dislocation should be suspected. Nevertheless, identification of IOM injuries amid the forearm trauma is difficult. However, magnetic resonance imaging (MRI) and ultrasound (US) showed a similar ability to reveal damage and destruction on the central parts. As a result, choosing the appropriate method shall be on a case-to-case basis. Identifying these injuries early is paramount to avoid the high morbidity associated with untreated cases (Fester *et al*., 2002; Rodriguez-Martin & Pretell-Mazzini, 2011; Rehim *et al*., 2014; Foran *et al*., 2017; Artiaco *et al*., 2020).

Management

Due to the severity of this fracture and the high morbidity rates, the emergency department team shall refer these cases to an orthopedic surgeon immediately. Management of these cases at the ER level includes ice, immobilization, the elevation of the forearm, and rest. Moreover, a closed reduction should be tried, however, if entrapment of the annular ligament within the joint is there, the reduction can be difficult. If obtainable, sugar–tong splint shall be applied till the orthopedic arrives. Emergent consultation is a must in any open fracture and vascular compromise. These patients have an unstable joint n at least one of the two broken lockers must be reconstructed to reacquire the joint function and avoid any further longitudinal instability. Non-operative management can be done in children if the ulna had an incomplete fracture (greenstick) or a plastic deformity (bowing or bending with no fracture). Closed reduction and splinting of the elbow with full supination, and 110 degrees of flexion for 6 weeks is done (Schlickewei & Oberle, 2005).

Surgical repair by osteosynthesis is the usual treatment of the broken bones to repair the MRUJ, and IOM does not need reconstruction. These are done for children with full fracture and most adults cases. The most common operative fixation method is by an ORIF. Usually, this is done by one compression plate anchored distally and proximally with six cortical screws. Once the fracture is realigned the reduction of the radial head is easy. After the fixation, the orthopedic must evaluate the DRUJ and PRUJ to confirm stability and reduction of the ulnar and radial head. If any dislocation or instability is still detected, open reduction and ligamentous repair of the PRUJ or DRUJ, or temporary fixation of PRUJ shall be done. Post-operative patients are then placed on a long arm splint. This splint shall be placed with full supination and the angle of elbow fixation differs based on the type, with type II placed at 70 degrees and the rest at 100 degrees. Oblique and short fractures are stabilized with intramedullary nail titanium fixation (Laun *et al*., 2015; Adams, 2017).

Regarding recovery, many factors play a role in it and its duration. These include the severity of the injury, the personal healing ability, and the planned usage of the extremity. Nevertheless, the rehabilitation usually starts after two weeks from the surgery. The main goal is to recover the full range of motion, fine skills, with no pain. Usual return to normal full activity takes between 2 to 3 months. Nevertheless, manual workers and athletes have a longer rehabilitation due to their higher demand activity and full recovery may take up to 4 months. Moreover, the hardware placed is usually left and only 10% of cases need removal (Rehim *et al*., 2014; Stragier *et al*., 2018; Artiaco *et al*., 2020).

A possible complication of these fractures such as nerve injuries, malunion, and nonunion can occur. Regarding nerve injuries, they can happen due to laceration, and/or entrapment. The most common nerves affected are the radial and median nerves. Moreover, posterior interosseous nerve palsy is the most common motor deficit. These injuries are seen more with type II fractures due to radial head compression and/or contusion against the supinator muscle. However, these injuries usually do not need any treatment and most cases resolve completely within 12 weeks. Nonunion and malunion can happen in up to 10% of cases which is very high compared to the average forearm fractures rate of only 2%. Other possible complications include; acute compartment syndrome, elbow stiffness from protracted immobilization in adults, ulnohumeral osteoarthritis, radioulnar synostosis, myositis ossificans, and wound infections (Adams, 2017; Stragier *et al*., 2018; Artiaco *et al*., 2020).

Overall, children have better clinical outcomes than adults which can be attributed to their ability to heal faster, remodeling of small-angle deformities, and solidity of these fractures. Adults usually have more complex injuries and the recovery rate depends on the complexity and type with type 2 being the worse. Any other fractures presenting with it also worsen the outcomes like coronoid process fractures and radial head. Longer staying complications of shortening of the limb, persistent angulation, chronic pain, and limited range of motion can be seen (Tompkins, 1971; Bae & Waters, 2005; Artiaco *et al*., 2020).

CONCLUSION

The forearm is one of the most important structures of the upper limb, thus any fractures and/or dislocations are clinically important. Monteggia fracture is one of the most common injuries of this are, and even though it can be easier to diagnose on radiologic studies it can be tricky to diagnose clinically. The importance of diagnosing this injury along with any other damage is vital since it is an orthopedic emergency and warrant an immediate referral. Most cases are treated surgically and will

need a long rehabilitation course taking up to months. Nevertheless, many complications can occur in the pre-operative, post-operative, and even after rehabilitation. As a result, further studies into recognizing the pattern associated with higher morbidity, complications, and worse outcomes shall be done.

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