Monteggia Lesions

In Children

Current Concepts

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HOW HAS

THE MANAGEMENT OF MONTEGGIA

FRACTURES

CHANGED?

HISTORICAL ASPECTS

Giovanni Battista Montaggia first described this fracture pattern in 1814 (12). During the 1900’s following his original description many other authors such as: Smith (17), Speed and Boyd (18), Evans (7), Wright (24), Penrose (14), and Tompkins (20), produced articles that theorized the mechanisms of the various types of Monteggia fractures.

Still the best and most complete description of the various patterns was the work of Jose Luis Bado of Montevideo, Uruguay. He coined the term Monteggia Lesions subdividing this general group of injuries into four types with equivalents of each type (1,2,3). His work has stood the test of time.

WHAT HAS CHANGED?

The work of the aforementioned authors has given us a better understanding of this injury. We now have more clearer concepts of the mechanism of injury of the various types. We now have a better idea of when and how to intervene surgically. We now have more experience with the late reconstruction of the missed injuries. While originally felt to be almost unknown in children, we now have more reports and experience with Type IV Lesions in the pediatric age group.
Our experience has taught us that these Monteggia injury patterns carry a **better prognosis in the pediatric age group** (8,21,22).

**CLASSIFICATION**

It is this author’s opinion that the most useful classification is that originally proposed by Bado in 1958 (1). This classification entails four true lesion patterns each with a set of equivalents (Fig 1).

![Classification Diagram](image_url)

**FIGURE 1. Bado’s classification.**

(A) **Type I anterior dislocation:** The radial head is dislocated anteriorly; the ulna has a short oblique or greenstick fracture in the diaphyseal or proximal metaphyseal area.  

(B) **Type II posterior dislocation:** The radial head is posteriorly or posterolaterally dislocated; the ulna is usually fractured in the metaphysis in children.  

(C) **Type III lateral dislocation:** There is lateral dislocation of the radial head with a greenstick metaphyseal fracture of the ulna.  

(D) **Type IV anterior dislocation with radius shaft fracture:** The pattern of injury is the same as with a Type I injury with the inclusion of a radius shaft fracture distal to the level of the ulnar fracture.  

CHARACTERISTICS AND MANAGEMENT

(By Bado Types)

TYPE I LESIONS

Description

The Type I lesion involves an anterior dislocation of the radial head with an associated fracture of the ulnar diaphysis (usually a short oblique or complete greenstick pattern). Letts and associates (9) have subdivided this type based upon the type of ulnar fracture pattern, i.e., plastic deformation, greenstick or complete. Recently Lincoln and Mubarak (10) have demonstrated that the so-called isolated radial head dislocation is a variant of the Type I lesion because there is almost always subtle evidence of plastic deformation of the ulna. This is manifest by the loss of the normal straight line of the posterior of aspect of the shaft of the ulna (Fig. 2).

![FIGURE 2. Plastic deformation of the ulna. (A) An anterior dislocation of the radial head. Notice that there is an anterior bowing of the shaft of the ulna (line+ arrow). (B) Opposite normal side for comparison. Notice that the posterior aspect of the ulna is completely straight (line).]

Incidence

Type I lesions represent 70% of all Monteggia lesions (19).

Mechanism of Injury

Three major mechanisms have been proposed as producing this type of Monteggia lesion.
**Direct blow**

This was originally proposed by Smith (167), along with Speed and Boyd (18). It was theorized that a direct blow to the posterior aspect of the forearm first breaks the ulnar shaft and then forces the radial head to dislocate anteriorly. There has been almost no evidence to support this as being a mechanism in children.

**Hyperpronation**

This was a popular mechanism proposed in the late 1940s – early 1950s by Evans (7). He theorized that when the child fell on the outstretched arm that there was a hyperpronation force applied which fractured the ulnar shaft and forced the radial head to dislocate. His theory was based upon fracture patterns produced in static amuscular cadaver forearms. Again the fracture pattern of the ulna is oblique not spiral as would be seen in a rotational mechanism.

**Hyperextension Mechanism**

This mechanism proposed by Tompkins in 1971 is the one most accepted today because it fits the injury pattern seen. It occurs in three phases (Fig. 3):

**Hyperextension of the elbow (Fig. 3 left).** This occurs when the child falls and tries to break his or her fall with the outstretched arm forcing the elbow into extension.

**Radial head dislocation (Fig. 3 center).** During this process of extension, contracture of the biceps resisting the extension moment causes the radial head to dislocate.

**Fracture of the ulnar diaphysis (Fig. 3 right).** With the radial head dislocated all of the weight of the body is transmitted through the forearm is concentrated in the ulnar shaft. The thin shaft cannot take the full weight-bearing stress and thus fails in tension producing an oblique complete or greenstick fracture.
FIGURE 3. Thompson’s Hyperextension Mechanism. (Left) **Hyperextension**: Forward momentum caused by a fall on an outstretched hand forces the elbow into extension. (Center) **Radial Head Dislocation**: The biceps contracts, which forcibly dislocates the radial head. (Right) **Ulnar Fracture**: forward momentum causes the ulna to fracture due to tension on the anterior surface. (reproduced with permission from: Part III Monteggia Fracture-Dislocations in Children, Chapter 9 Fractures of the Radius and Ulna. *in Fractures Vol. III Fractures in Children.* Rockwood C A Jr Wilkins K E Beaty J H eds, fig 9-131, Lippincott-Raven, Philadelphia, Pa., 1996)

**Treatment**

*Non-Operative*

Non-operative management is more likely to be effective in children (6,22). It involves three processes: 1. Reduction of the ulnar shaft, 2. Reduction of the radial head, and 3. Postoperative immobilization.

**Reduction of the ulnar shaft.** The reduction of the ulnar shaft is the key to success. First, the length must be re-established. Second, the angular malalignment must be corrected. This may include full correction of the plastic deformation (Fig. 4).

FIGURE 4. Type I reduction of the ulna. A. Radiograph of a 7-year-old demonstrating a Type I lesion and with a greenstick fracture of the ulna. Notice there is anterior bowing of the ulna.
Reduction of the radial head. Often when the ulnar shaft is reduced the radial head automatically reduces. If not, manual pressure directed posteriorly against the proximal radius, along with flexion of the elbow, may facilitate the reduction process (Fig. 5).

Post Reduction Immobilization. The deforming forces must be alleviated. First, the elbow should be flexed up to 110-120 degrees to decrease the force of the biceps on the proximal radius. There should be three-point molding of the forearm portion to
counteract the tendency for the forearm flexors to bow the ulna in a radial direction (Fig. 6).

![FIGURE 6.Post reduction immobilization. Post reduction with some flexion in a simple posterior splint of the patient represented in Figure 4A. The center of the proximal radius now remains aligned with the center of the capitellum (arrows).](image)

**After Care.** Radiographs of the elbow should be obtained at 1 week post reduction to be sure there is not a late redisplacement of the radial head (23). This author usually maintains the long-arm cast for three weeks changing to a short-arm cast for another three weeks.

**Operative Indications**

The usual operative indications involve a failure to adequately reduce or stabilize the ulna or radial head.

**Failure of Ulnar Reduction.** The stability of the ulna usually dictates the stability of the radial head (16).

**Posterior Angulation.** Often the proximal ulna will tend to bow posteriorly from the force of the triceps (Fig. 7).

![FIGURE 7 Posterior ulnar bowing. When the cast was removed there was a posterior bowing of the ulna produced by the pull of the triceps (arrow).](image)

**Radial Bow.** The ulnar shaft will bow in a radial direction due to the force of the forearm flexors. (Fig. 8A). This requires that three point molding be incorporated in the
sugar tong splint or cast. (Fig. 8B). In many cases especially if the child has a small short forearm, it may be difficult to prevent this ulnar bowing with non-operative methods alone. In these Type I lesions in children intramedullary fixation can be used to prevent these angular deformities. The intramedullary fixation can be achieved either antegrade through the olecranon or retrograde through the distal metaphysis (Fig. 8C,D). If the ulna is comminuted plate fixation may be necessary.

**Failure of ulnar reduction.** A. The forearm flexors have a tendency to mold the ulna in a radial direction (arrow). B. This must be counteracted by applying three-point pressure to the forearm with it in a neutral location (arrows). (reproduced with permission from: Part III Monteggia Fracture-Dislocations in Children, Chapter 9 Fractures of the Radius and Ulna. in Fractures Vol. III Fractures in Children. Rockwood C A Jr Wilkins K E Beaty J H eds, fig 9-137, Lippincott-Raven, Philadelphia, Pa., 1996) C. Intramedullary pin fixation of the ulna with a distal-to-proximally placed K-Wire. D. Intramedullary pin fixation of the ulna with a Steinmann Pin placed from the olecranon and passed distally. These pins can be removed very quickly as soon as there is good callus at the ulnar fracture site.

**Failure of Radial Head Reduction.** Reduction of the radial head usually may be prevented by interposition of the annular ligament, bony fragments of the capitellum or radial head or by the radial nerve. The most direct approach is by a posterolateral surgical dissection between the anconeus and extensor carpi ulnaris. If there is a need to
provide plate fixation, the Boyd approach (5) extends the dissection distally to visualize the proximal ulna.

**TYPE II LESIONS**

**Incidence**

Type II lesions are extremely rare in children. They occur in about 6% of all Monteggia lesions (19).

**Mechanism of Injury**

Penrose (14) postulated that a longitudinal proximally directed force up the forearm with the elbow semi-flexed caused the posterior ulnar cortex to fail. This subsequently resulted in an apex-posterior angulation of the ulna which causes the radial head to dislocate posteriorly. Thus it is the tension side of the ulna that fails on the posterior aspect at the olecranon-diaphysis junction (Fig. 9)

![FIGURE 9. Mechanism of injury for type II fracture-dislocation. (A) With the elbow flexed approximately 60°; if a force is applied longitudinally parallel to the long axis of the forearm a posterior elbow dislocation may occur. (B) If the integrity of the posterior cortex of the ulna is compromised, a type II lesion will occur. (reproduced with permission from: Part III Monteggia Fracture-Dislocations in Children, Chapter 9 Fractures of the Radius and Ulna. in Fractures Vol. III Fractures in Children. Rockwood C A Jr Wilkins K E Beaty J H eds, fig 9-141, Lippincott-Raven, Philadelphia, Pa., 1996)](image)

**Treatment**
**Closed Reduction**

The ulna is reduced by applying longitudinal traction with the elbow extended (Fig. 10 A). Direct pressure anteriorly on the radial head will often facilitate its reduction (Fig. 10 B).

![FIGURE 10. Reduction of the type II lesions. A. First the elbow is held at 60° of flexion; while traction is applied in line with the forearm (arrow). B. To achieve the final reduction (facing arrows), the elbow is brought into full extension. It may be necessary to apply pressure in an anterior direction over the radial head (dotted arrow) to complete the reduction. (reproduced with permission from: Part III Monteggia Fracture-Dislocations in Children, Chapter 9 Fractures of the Radius and Ulna. In Fractures Vol. III Fractures in Children, Rockwood C A Jr Wilkins K E Beaty J H eds, fig 9-142, Lippincott-Raven, Philadelphia, Pa., 1996)](image)

**Immobilization**

Because this is a flexion type of injury and the anterior cortex is usually intact, the ulna is most stable with the elbow in extension. Thus the three point molding is made center posterior to maintain the ulna reduced.

Because the ulna fracture is usually metaphyseal in location, the healing is rapid and three weeks is usually sufficient before the patient can be taken out of the cast and resume motion. Because the elbow has been in extension it may take a while for elbow flexion to return.

**Operative Indications**

Since there is very little experience with this lesion there is very little known about the operative indications. The operative indications would be the same as in Type I lesions, i.e. unstable ulna fracture that would require either intramedullary or plate
fixation or irreducible radial head which would require removal of the interposing substance.

**TYPE III LESIONS**

**Incidence**

Type III lesions are the second most common occurring in 23% of all Monteggia lesions (19). It also is the most commonly associated with irreducibility of the radial head because of interposed annular ligament. The incidence of posterior interosseous nerve is fairly high with this injury as well.

**Mechanism of Injury**

Wright proposed that this injury was due to a varus stress on the extended elbow. The ulna fails first as a greenstick olecranon fracture. The radial head then dislocates laterally or anterior laterally (Fig. 11).

![FIGURE 11. Type III Lesion. This lesion comprises a radially angulated greenstick fracture of the ulna with a lateral dislocation of the radial head.](image)

**Treatment**

*Non-Operative Management*

The non-operative method of reduction usually involves reversing the mechanism. The elbow is hyper extended to stabilize the olecranon (Fig. 12). With the elbow in
extension a valgus force is applied to the olecranon to fully correct the greenstick fracture. It may even have to be slightly overcorrected. The radial head will often then reduce spontaneously but local pressure directed medially over the radial head may be necessary to complete the reduction.

FIGURE 12. Reduction of Type III Lesion. Valgus stress is placed on the ulna at the fracture site (arrow), producing clinical realignment. The radial head may reduce spontaneously or need a little push (reproduced with permission from: Part III Monteggia Fracture-Dislocations in Children, Chapter 9 Fractures of the Radius and Ulna. in Fractures Vol. III Fractures in Children, Rockwood C A Jr Wilkins K E Beaty J H eds, fig 9-144, Lippincott-Raven, Philadelphia, Pa., 1996).

Four weeks is usually enough to allow the greenstick to heal rapidly. The arm is usually immobilized the same as for Type I lesions. Although many people now feel that because of the tendency for the olecranon to re-deform, the arm should be immobilized with the elbow in extension, so a valgus force can be applied to the ulna.

Operative Indications

Again, the operative indications are the same for Type III lesions as for Type I lesions i.e.: the need to stabilize the ulna or to remove the interposed tissue preventing radial head dislocation (Fig. 13).
FIGURE 13. Re-reduction of type III lesion. (A) Radiograph of a 6-year-old with a type III injury with lateral dislocation of the radial head. This patient was placed in a long-arm extension cast. The reduction appeared satisfactory. (B) At two weeks there appeared to be some bowing of the ulna and some concern about subluxation of the radial head. The long axis of the radius was lateral to the long axis of the center of the capitellum (arrows). (C) An arthrogram revealed that the radial head was lateral to the articular surface of the capitellum (arrow). (D) The ulnar fracture was then re-reduced and stabilized with a pin placed from the proximal distal down the intramedullary canal holding the radial head in a reduced position.
Complications

The most common complication is a posterior interosseous nerve injury which usually resolves rapidly and spontaneously. There may be residual ulnar bowing either due to inadequate reduction of the olecranon or proximal ulna. The forearm muscle forces can also contribute to this radial bow of the ulna. If the radial head develops a symptomatic subluxation, an osteotomy of the olecranon or proximal ulna may be required.

TYPE IV LESIONS

Incidence

Originally, Type IV lesions were felt to be rare in children. Unfortunately, they do present in about 1% of all Monteggia lesions (19). Often the radial head dislocation is not appreciated because the focus is on the shaft fracture.

Mechanism

Because of its rarity, the mechanism of Type IV lesions is not well defined. It probably is the same as for Type I lesions.

Treatment

This usually requires surgical stabilization of both the radius and ulna shafts first. Once the forearm is stabilized it can then actually be treated like a Type IV lesion. In the younger children, intramedullary rods are usually sufficient to stabilize the forearm bones. Plate fixation may be required in the older child. Non operative methods are often difficult because of the floating nature of the proximal forearm. Experience has shown that these may require repeated manipulations to maintain correct alignment. Immobilization is maintained with the elbow in hyperflexion in a long-arm cast for about three weeks and then a short-arm cast or splint for another three-to-four weeks.

COMPLICATIONS

(ALL LESIONS)
OLD UNDETECTED FRACTURE-DISLOCATIONS

Indications for Treatment

This is a short discussion to determine which are the best procedures. Patients should be less than 12 years of age and should have absence of any radial head changes or overgrowth of the radius. After three years post-dislocation the radial head becomes misshapen and overgrown. Thus a congruent proximal radial ulnar reduction is often difficult to accomplish. Papandrea and Waters (13) report a very high complication rate with reconstruction of unreduced radial head. They feel that surgery is indicated in those who have:

1) progressive radial capitellar subluxation or dislocation;
2) progressive valgus deformity;
3) a limited range of available or forearm motion; and
4) pain at the malaligned radial capitellar or radial ulnar articulations.

It is still controversial as to whether a completely asymptomatic functional radial head dislocation should undergo clinical reconstructive process.

Techniques

Two Deformities To Be Addressed

1. The deformity of the ulna, which may need to be corrected with an osteotomy. This can be stabilized with a plate or intramedullary fixation.

2. The reduction of the radial head and ligament reconstruction. The most widely used technique is that of Bell-Tawse using a strip of triceps tendon (4). Recently, Lloyd-Roberts (11) recommended using the lateral portion of the triceps instead of the central portion. Rather than passing the triceps tendon through the olecranon, it can be attached proximally with either micro staples or a bone anchor. Peterson (15) has posed a complex reconstruction, which attempts to completely reconstruct anatomically the orbicular ligament.

Some authors feel that the annular ligament reconstruction is not necessary and that an osteotomy of the ulna is all that is needed. In fact it has been recommended that the osteotomy be over correcting (13). The radial head stabilization can be done with a large transcapitellar pin. It must be large enough so that it does not break. An alternate technique would be to include a transverse proximal radial-ulnar pinning or
immobilizing the elbow in extension. Post-operatively, the extremity needs to be immobilized for six weeks. The parent must be warned that there may be a decrease in supination or pronation post-operatively.

**Nerve Injuries**

*Radial (Posterior Interosseous Branch)*

This is the most common and usually resolves spontaneously in nine-twelve weeks.

*Median and Ulnar Nerve Injuries*

These injuries are usually very rare.

*Tardy Ulnar Nerve Palsy*

Tardy ulnar nerve palsy is usually due to a chronic valgus the elbow of along with long-term unreduced radial head dislocation.

**Ectopic Ossification**

*Periarticular Ossification*

This condition is usually seen with a chronically dislocated radial head. It will usually disappear with the reduction of the radial head.

*Myositis Ossificans*

This occurs if there is an associated radial neck fracture or if there is too vigorous physical therapy.

**REFERENCES**


