Case report

Monteggia variant with posterior elbow dislocation and radial shaft fracture: A case report

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\textbf{A B S T R A C T}

\textbf{Introduction:} The most commonly used Bado classification encompasses the large majority of Monteggia fractures, however, certain patterns cannot be classified with this system. Monteggia injuries and Monteggia-Variants are uncommon but serious injuries that can have dire consequences if not identified and treated appropriately. This paper aims to review relevant literature, discuss current classification systems, and present a case of an atypical fracture pattern.

\textbf{Presentation of case:} We present a case of a unique Monteggia variant in an adult that to our knowledge has not been discussed in the literature. The patient presented to the emergency department after a fall while skateboarding. Plain radiographs demonstrated a displaced proximal radial shaft fracture with posterior elbow dislocation and an intact ulna. The patient was closed reduced in the emergency department, and taken to the operating room thirteen days post injury. Open reduction internal fixation with compression plating of the radius was performed, and the patient was discharged home without complications.

\textbf{Discussion:} As our knowledge of the forearm and forearm injury patterns has expanded, it has become increasingly clear that our current classification systems and algorithms may not suffice. Monteggia variants are difficult to diagnose, and they also portend to have poorer outcomes. It is to our knowledge that this unique Monteggia Variant has not been previously described.

\textbf{Conclusion:} The successful identification and classification of forearm fractures is vital to proper treatment. It is our hope that awareness of this Monteggia-variant contributes to the knowledge base of forearm fracture-dislocations and their treatment.

\textbf{1. Introduction}

The Monteggia injury was first described by Giovanni Battista Monteggia in 1814 as a radial head dislocation combined with a fracture of the ulnar shaft [1]. It was first classified by Bado in 1967, and this classification system is still widely used today [2]. However, it is a frequent occurrence to have fractures that do not fall under the Bado classification system. These fractures are named as variants, in example, Monteggia-variant or Monteggia-equivalent. This leads to a broader classification system. These fractures are named as variants, in example, Monteggia-variant or Monteggia-equivalent. This leads to a broader classification system. These fractures are named as variants, in example, Monteggia-variant or Monteggia-equivalent. This leads to a broader classification system. These fractures are named as variants, in example, Monteggia-variant or Monteggia-equivalent. This leads to a broader classification system.

Monteggia fractures account for less than 2 % of forearm fractures [3]. This relatively rare injury pattern is even rarer in adults [3]. These fractures are often improperly diagnosed in the emergency department. One study found that approximately 25.5 % of patients had a missed diagnosis by the involved radiology group, 14.9 % of fractures were missed by the bedside clinicians including orthopedic surgeons, and 10.6 % were missed by both groups [3]. Because of the complicated anatomy of the forearm and elbow joint, in addition to the wide variety of injury patterns, it may be difficult for physicians to recognize these injuries. Certain clinical examination findings may be helpful to providers if recognized early. Patients typically present with pain and swelling at the elbow, and should be evaluated for skin integrity, gross deformity, loss of range of motion, neurovascular status, and posterior interosseous nerve (PIN) neuropathy.

The forearm anatomy consists of the radius and ulna, with one functional and two anatomical joints. The functional joint consists of the
middle radioulnar joint involving the forearm bones and interosseous membrane. The two anatomical joints consist of the proximal and distal radioulnar joints (PRUJ/DRUJ). As discussed above, Bado is the most well-known classification of Monteggia fractures [3]. The most commonly seen Bado subtype is Type I, consisting of 70% of Monteggia fractures [3]. This subtype includes a fracture of the proximal or middle third of the ulna with anterior dislocation of the radial head. Bado Type I Monteggia fractures are the most common type in children, accounting for 70% of pediatric Monteggia fractures but only 15% of Monteggia fractures in adults [4]. Bado Type II consists of a fracture of the proximal or middle third of the ulna with posterior dislocation of the radial head. Bado type II Monteggia fractures make up 80% of Monteggia fractures seen in adults, the most common pattern [4]. Type III are fractures of the ulnar metaphysis with lateral radial head dislocation [3]. Type IV involves fracture of the proximal or middle third of the ulna and radius with dislocation of the radial head in any direction [3]. Bado Type II Monteggia fractures have a further sub-classification known as the Jupiter Classification, which was described in 1991 [5]. Type IIA fractures occur at the coronoid level, Type IIB occur at the metadiaphyseal junction, Type IIC occur distal to the coronoid, and Type IID have a fracture extending to the distal half of the ulna [5].

It is also important for orthopedic surgeons, emergency room physicians, and other treating clinicians to be aware of the common complications that can arise from Monteggia fractures, as well as the harmful effects of a delayed diagnosis. Monteggia fractures have a higher nonunion rate of 2–10% when compared to other forearm fractures of 2% [6]. PIN neuropathy is the most common cause of motor deficit occurring in up to 10% of patients [6,7]. Majority of patients with PIN neuropathy have resolution of symptoms by 9–12 weeks without intervention [6]. Persistent radial head dislocation is a complication that can result from Monteggia fractures that are missed on initial evaluation [3]. Mal-union with radial head dislocation is usually secondary to malalignment of the ulna. This can normally be corrected with an ulnar osteotomy and open reduction internal fixation of the radial head. Also of note, the radial head becomes exceedingly difficult to reduce if left dislocated for longer than two to three weeks [3]. This is secondary to fibrosis occurring in the ulnar notch [3]. Adult patients with Bado Type II injuries showed significantly poorer outcomes [4]. Additionally, patients with intra-articular radial head fractures and fractures of the coronoid process had worse overall outcomes [4].

It can be seen from the above background and data that Monteggia fractures are complex injury patterns, with a plethora of complications which justify the need for early identification and proper treatment. Unfortunately, as noted in the above statistics, these fractures are commonly missed or mis-diagnosed, even by orthopedic surgeons who should be the most aware. To complicate the matter at discussion, there is a well-established classification system known to the majority of orthopedic physicians that fails to recognize certain variants that occur in reality. Here we present a case report of a 22 year old male who sustained a unique Monteggia variant lesion, along with their treatment plan and follow up care.

The work in this case report has been reported in line with SCARE criteria [8].

2. Presentation of case

Informed consent was obtained from the patient prior to starting this manuscript. A 22 year old male with a past medical history of anxiety, post-traumatic stress disorder, and marijuana use presented to the emergency department at an outside facility for evaluation of a left arm injury after a fall while skateboarding. Patient was currently unemployed at the time of surgery and living at home with his mother. Patient reported doing a backflip in a bowl and falling on his left arm. He reported feeling an immediate initial pop, and then as he was bracing for impact felt a second pop. Upon examination, the patient was found to have limited range of motion (ROM), intact skin, and intact neurovascular function. The radiographs of the injury films are shown in Fig. 1. It is immediately apparent that this is a closed complex fracture dislocation of the left elbow. Breaking this injury down further, there is a posterior dislocation of both the radio-capitellar and ulno-humeral joints. Additionally, there is a fracture of the proximal third radius shaft with an anterior apex. Take note that there is no associated fracture to the ulna that is commonly seen in the large majority of Monteggia fractures.

The patient initially underwent urgent closed reduction of the left elbow dislocation and was placed in a long arm splint. The post reduction films are demonstrated in Fig. 2. These images demonstrate a successful closed reduction of the elbow joint, however the radial shaft remained displaced. The patient was discharged home from this outside facility and presented to our clinic nine days from the date of injury. In the clinic, the patient was alert and oriented without any significant distress. His splint was still maintained and intact, and he was without any neurovascular deficits. Given the continued displacement of the radius, open reduction internal fixation was recommended. After discussing the risks and benefits to the patient, they agreed to undergo the aforementioned procedure.

The patient was taken to the operating room for open reduction and internal fixation of the left radius thirteen days from date of injury. The attending orthopedic surgeon performed the surgery with the assistance of residents. The proximal radius was approached using a volar approach of Henry between the brachioradialis and flexor carpi radialis. The supinator was carefully dissected off the radius to expose the fracture site. Care was taken to protect all neurovascular structures throughout the procedure. The fracture site was identified, prepared for reduction, and reduced with the use of clamps. A seven hole limited contact dynamic compression plate was applied in compression mode using non-locking 3.5 mm cortical screws. Once all hardware was in place final x-rays revealed satisfactory position of the fracture and hardware, and concentric reduction of the elbow. The post-operative films can be seen in Fig. 3. The elbow was then ranged to assess for stability using live fluoroscopy demonstrating a reduced elbow through full range of motion. A shuck test was performed to assess the DRUJ which was stable. The wound was then irrigated and closed with application of a long arm splint.

He was discharged home that same day. The patient was given instructions to remain non weight-bearing of the left upper extremity and to return to the clinic in 10–14 days. The patient presented for his two week follow up appointment as instructed. Radiographs on this day demonstrated intact hardware without any change in fracture or hardware alignment and positioning. These radiographs are demonstrated in Fig. 4. He remained neuro-vascular intact without any evidence of wound complications. His range of motion was from 30 to 95 degrees. Sutures were removed on this visit and the splint was discontinued. He was discharged from this clinic visit with plans to remain non-weight bearing, begin physical therapy, and follow up in four weeks. Unfortunately, the patient was then lost to follow up without any further documentation of imaging or evidence that he was attending therapy. However, the patient did present to the emergency department for unrelated reasons at the approximate one year and 18 month marks. At these visits there was mention of his recent forearm surgery, and normal examination of his extremities without any related complaints to the left elbow or forearm was noted.

3. Discussion

The injury described in this case report does not depict the classic pattern of an ulnar shaft fracture with radial head dislocation. Instead, we present a proximal radial shaft fracture with posterior dislocation of the radio-capitellar and ulno-humeral joints. Note also that there was no fracture or deformation of the ulna. Using the Bado classification this fracture most closely resembles a Type II given the posterior dislocation. However, it also resembles a Type IV given the fracture of the radial
Nonetheless, this fracture pattern clearly is more complex and does not fit into the most widely known classification system for these injury patterns. It is recognized that more than 70% of Monteggia fractures in adults are Bado type II [3]. Relatively few papers discuss the long-term prognosis of Monteggia fractures treated operatively in adults, but there is some evidence to support that Bado Type II fractures may have a worse prognosis [4,9]. In a retrospective study of 47 patients with a mean follow-up of 8.4 years, patients with posterior Bado Type II fracture patterns had significantly poorer functional results using the Broberg and Morrey elbow scale [4]. In another study of 67 patients with Monteggia fractures, Bado classification II or IV fractures tended to have poor outcomes, while I and III had good or excellent outcomes [9]. In this patient's case, most closely resembling a Type II or Type IV, one could presume them to have poorer outcomes. However, this presumption highlights the uncertainty of these variants as they do not fall into a specific category, and there is a paucity of literature pertaining to the long term outcomes.

Two papers were identified that discuss Monteggia variants and their long term outcomes after surgery. Egol et al. performed a retrospective study on patients who sustained an ipsilateral proximal ulna fracture, radial head or neck fracture, and radial head dislocation. They similarly found that patients who most closely fell into the Bado Type II pattern had poorer outcomes [10]. Heterotopic ossification occurred in 35% of the sample population, and 70% developed arthritic changes within two years of follow up. Also, 40% required revision surgery and 45% had fair or poor outcomes on the Broberg and Morrey scale [10]. Furthermore, the mean disability of the arm, shoulder, and hand score was lower than the general population [10]. Another paper by Singh et al. performed a retrospective review of Monteggia variants, excluding all patients with classic fracture patterns, and including fractures of the ipsilateral proximal ulna together with a radial head or neck fracture. The results demonstrated patients who sustained articular involvement, comminution of the ulna or radial head, and those with coronoid fractures had poorer outcomes [11]. Although the discussion of long term

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Fig. 1. Four orthogonal radiographic views of the elbow and forearm demonstrating a posterior elbow dislocation with an associated proximal radial shaft fracture. No evidence of an ulna shaft fracture identified.

Fig. 2. Two orthogonal radiographic views of the elbow status post successful closed reduction and long arm splint application. There is a concentric anatomic reduction of the elbow, however displacement of the radius remains.
Early recognition and careful consideration on proper surgical technique could help to reduce the poorer outcomes that are higher in these patient populations.

As previously mentioned, not all Monteggia fractures fall into this classification system. Artiaco et al. proposed a classification system for forearm and Monteggia variant fractures. This system is based on a “locker” concept which is extrapolated from the functional and anatomic joints of the forearm as described above in the introduction. There are 13 fracture patterns described. In brief, a number one signifies the proximal forearm joint including the PRUJ, two signifies the middle radioulnar joint consisting of the forearm bones and interosseous membrane, and three is indicative of the DRUJ. There are also letters to be added, R stands for concomitant radius fracture, I meaning IOM rupture, and U implying concomitant ulna fracture. This classification system is more inclusive of variants or equivalents of Monteggia fractures, but is not commonly utilized. Our patients fracture pattern is a radial shaft fracture with posterior dislocation of the ulno-humeral and radio-capitellar joints. Therefore it is most similar to a 1.2IR. Demonstrating PRUJ disruption, middle radio-ulnar/IOM disruption, in addition to a radial shaft fracture. However, this classification system is still not perfect as it cannot take into consideration the ulno-humeral dislocation seen in our patient. Overall, this classification system does solve the issue of recognizing Monteggia variants in the real world. Additionally it provides the recommendation that a “two-locker” or “three-locker” injury would go to surgery. This is a simple concept for a treating surgeon to consider when faced with a variant pattern that may be unfamiliar.

Lastly, we find it important to highlight the unique nature of the case presented. To the best of our knowledge this specific pattern has not been discussed before in the literature. This pattern was not described or included as a variant in either of the retrospective reviews discussed above. Additionally, after a thorough review of case reports on Monteggia variants, it remains a unique outlier. Kamudin et al. described two unique variants, one including a classic Bado Type III with an ipsilateral distal radius and ulna fracture, while the other involved a Bado Type I fracture where the proximal ulna fracture extends into the ulno-humeral joint. Alrashidi et al. described a single case with a comminuted proximal ulna fracture with anterior displacement, and a laterally displaced and comminuted radial head. Bhandari et al. describes a Type IV lesion with an associated radial shaft fracture and plastic deformation of the distal ulnar shaft. Jain et al. describes a Type 1 variant with an associated humeral shaft fracture. Lastly, one case report most closely resembled the variant discussed in our paper. Laratta et al. described a posterior ulno-humeral dislocation with anterior radial head dislocation, with an associated radial shaft fracture, as well as disruption of the DRUJ. Ultimately, after a thorough review of the literature, our cases unique pattern of a posterior ulno-humeral and radio-capital joint dislocation, and radial shaft fracture without any fracture or deformation to the ulna has not been discussed before to our knowledge.

4. Conclusion

This paper highlights an unclassifiable Monteggia variant that to our knowledge has not been discussed before in the literature. There is a paucity of literature out there that attempts to re-classify the Bado system to include these Monteggia Variants. Although Monteggia variants are rarer than the classic patterns, recent studies demonstrate poorer outcomes for patients who suffer from these fractures. Overall, Monteggia fractures have a wide variety of complications, and early recognition and anatomic reduction are vital to mitigating these. With this paper we hope to bring awareness to this particular variant as well as Monteggia variants as a whole. Thus, future treating clinicians can make the appropriate diagnosis, have a thorough and critical pre-operative patient discussion and operative plan, and achieve the goal of restoring anatomical alignment and function.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Ethical approval

The site from which all data was gathered, does not require IRB approval for sufficiently anonymous case reports. However, a consent was completed for this patient, which is available upon request.
Fig. 4. Three orthogonal radiographic views from the first post-operative visit. When compared to the immediate post-operative films, there is no change in alignment or positioning of the fracture reduction or hardware.

Research registration

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Guarantor

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CRediT authorship contribution statement

Emilio L. Robles, DO: Study concept, writing the paper, collecting data.
Hillary Rolfs, DO: Co-author.

Damayea Hargett, MD: Primary Attending Surgeon, concept.

Declaration of competing interest

None.

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