



# Surgical Outcome of Neglected Monteggia Fracture-Dislocation in Pediatric Patients: A Case Series

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Received 2018 October 10; Accepted 2019 January 07.

## Abstract

**Background:** Treatment of Monteggia fracture-dislocations can become quite complicated when the diagnosis is delayed.

**Objectives:** We report the outcome of open reduction and ulnar osteotomy with annular ligament repair or reconstruction in pediatric patients with neglected Monteggia fracture-dislocation.

**Methods:** In a retrospective study, pediatric patients with neglected Monteggia fracture-dislocation who underwent open reduction and ulnar osteotomy with annular ligament repair or reconstruction were included. The radiologic evaluations included the assessment of the union of the osteotomy site and elbow joint degenerative changes or peri-articular ossifications. The clinical evaluation of outcomes included the range of motion (ROM) and the Kim elbow performance score (KEPS).

**Results:** A total number of seven patients with pediatric Monteggia fracture-dislocations and the mean age of  $6.6 \pm 2.7$  years were evaluated. The mean delayed time from injury to surgery was  $53.3 \pm 31.4$  days. The mean follow-up of the patients was  $30.8 \pm 25.5$  months. The mean flexion arc, supination, and pronation were  $137.9^\circ$ ,  $72.1^\circ$ , and  $65.7^\circ$ , respectively. Flexion contracture was present in two cases only. The mean KEPS of the patients was  $96.4 \pm 6.3$ . Accordingly, the outcome was excellent in six (85.7%) patients and good in one (14.3%). One ulnar nonunion and one heterotopic ossification were recorded as post-operative complications. No case of subluxation, dislocation, or degenerative joint disease was seen in our series.

**Conclusions:** Radial head reduction and ulnar osteotomy with annular ligament reconstruction result in acceptable radiologic and clinical outcomes in the management of neglected pediatric Monteggia fracture-dislocation.

**Keywords:** Neglected Monteggia Fracture-Dislocation, Radial Head Reduction, Ulnar Osteotomy, Pediatric

## 1. Background

The dislocation of the radial head in combination with the fracture of the ulna has been defined as Monteggia fracture-dislocation (1). Persistent radial head dislocation in Monteggia fracture-dislocation may cause increasing valgus deformity of the elbow with subsequent ulnar or radial nerve derangement (2, 3). The obstruction by the radial head could result in the restriction of the range of motion (3). The function of the elbow can be impaired by a combination of stiffness and instability (3). Moreover, secondary degenerative arthritis may be a late consequence of the Monteggia fracture-dislocation (2-4). Thus, it is crucial to diagnose and treat Monteggia fracture-dislocation as soon as possible.

Monteggia fracture-dislocations are uncommon injuries in children, accounting for about 1% of all pediatric forearm fractures (5). They are also one of the most fre-

quently overlooked injuries in children and nearly 50% of these fractures may be initially misdiagnosed (6). Treatment processes can become quite complicated when the diagnosis is delayed. While the nonoperative approach to pediatric acute Monteggia fracture-dislocations could result in the acceptable outcome in some cases (7), surgical treatment is inevitable when the interval between trauma and treatment exceeds three weeks (8).

There is no consensus regarding the standard treatment approach for misdiagnosed Monteggia injuries and thus, a variety of surgical procedures have been described for this correction (3). However, open reduction with ulnar osteotomy, with or without annular ligament reconstruction, is reported as the most commonly performed procedure with an acceptable pain reduction and deformity correction capability (3).

Only a few case series are available on the outcomes of

neglected Monteggia fracture-dislocations following open reduction and ulnar osteotomy with or without annular ligament repair or reconstruction (3).

## 2. Objectives

We report the outcome of open reduction and ulnar osteotomy with annular ligament repair or reconstruction in seven pediatric patients with neglected Monteggia fracture-dislocation.

## 3. Methods

The study was approved by the review board of our institute. Written informed consent was obtained from the patients' parents before entering the patient in the study. In a retrospective study, patients with neglected Monteggia fracture-dislocation who were referred to our center from January 2014 to October 2017 were included. Our inclusion criteria were the age of under 12 years and delayed diagnosis of at least four weeks (3). The patients that were not available for final evaluations (two patients) were excluded from the study. Overall, seven patients were assessed in the study.

Bado's classification that categorizes the Monteggia lesions into true Monteggia lesions and 'equivalent lesions' based on the mechanism of the fracture and the direction of the dislocation was used for typing of the injury (1). The demographic, clinical, and radiologic characteristics of the patients were extracted from the patients' medical records. Standard anteroposterior and lateral radiographs of the elbow were used for the evaluation of radiographic outcomes including the assessment of union of the osteotomy site, radial head subluxation, dislocation, deformation, or osteoarthritic changes at the articulating surfaces. Joint space narrowing was defined as an osteoarthritic change. Accordingly, the radiographic outcome was categorized as good (complete radial head reduction and no osteoarthritic change), fair (either radial head subluxation or osteoarthritic changes), and poor (radial head dislocation) (9). Lateral radiographs were used for the evaluation of subluxation. In this respect, if a line was drawn on the lateral elbow X-ray along the axis of the radius and bisecting the neck of the radius did not cross the middle third of the capitulum, it would be considered a subluxation (10, 11).

The outcome of surgery was assessed through the evaluation of a range of motion (ROM) and the Kim elbow performance score (KEPS) (10, 11). The KEPS includes four parameters with a maximum point of 25 in each category. The total score is interpreted as excellent (score of  $\geq 90$ ), good

(score of 75 to 89), fair (score of 60 to 74), and poor (score of  $< 60$ ) (10, 11).

The range of motion was assessed by a goniometer. Clinical evaluations were performed by a hand therapist who was not involved in the treatment of the patients or reporting the results.

### 3.1. Surgical Technique

The surgery was done as previously described with some minor modifications (12). After the injection of intravenous antibiotic (1 g cefazolin), the patients were placed in the supine position under general anesthesia and tourniquet control. Using the Kocher approach, a skin incision was made and extended along the ulnar shaft to expose both the radiocapitellar joint and the ulnar shaft. The fibrous tissue was removed to expose the radial head and annular ligament remnant. An ulnar osteotomy at the proximal metaphysis of the ulnar shaft was performed to ensure the postoperative stability of the radial head. The osteotomy site was then distracted and angulated. The final position of the ulna was guided by the reduction of the radial head and checked with fluoroscopy. The ulnar osteotomy was fixed with a 3.5-mm reconstruction plate. Subsequently, the remnants of the annular ligament were traced. If identified, they were repaired. In cases where we were able to find a shrinkaged but intact annular ligament, we used it by enlarging the orifice of it. If not, reconstruction was done using a small piece of triceps fascia fixed with transosseous sutures. The radial head was reduced and its stability was assessed intraoperatively using the ROM varus/valgus stress (13). Stability was achieved in all but one patient (case 3). In this patient, the radial head was fixed with a radiocapitellar pin. All surgeries were performed by the same hand surgeon (FNM).

### 3.2. Postoperative Protocol

After the operation, an elbow splint was applied with the elbow positioned at 90° flexion and the forearm in the neutral rotation for two weeks. Active forearm rotation, flexion, and extension of the elbow started after the removal of the splint, at week 2. We did not recommend any scheduled physiotherapy programs for our patients.

## 4. Results

A total number of seven patients with neglected Monteggia fracture-dislocation were included in this study, including six (85.7%) males and one (14.3%) female with the mean age of  $6.6 \pm 2.7$  years (range: 4 - 11.8 years). The mechanism of the injury was falling down in all patients. The mean delayed time from injury to surgery was  $53.3 \pm 31.4$

days (range: 30 - 105 days). The Bado type I, III, and IV was seen in four, two, and one patient, respectively (Figure 1). The mean follow-up period of the patients was  $30.8 \pm 25.5$  months (range: 3 - 70 months). The injury involved the dominant hand in two patients and non-dominant hand in the others. In five patients, the annular ligament was repaired using the injured ligament and in two patients, it was reconstructed. The demographic, clinical, and surgical characteristics of the patients are demonstrated in detail in Table 1.

The mean flexion arc of the patients was  $137.9^\circ \pm 6.4^\circ$  (range:  $130^\circ - 150^\circ$ ). Flexion contracture was present in two cases only (case 6:  $10^\circ$ , case 7:  $35^\circ$ ). The mean supination of the patients was  $72.1^\circ \pm 24.1^\circ$  (range:  $30^\circ - 90^\circ$ ). The mean pronation of the patients was  $65.7^\circ \pm 24.7^\circ$  (range:  $30^\circ - 85^\circ$ ). The mean KEPS of the patients was  $96.4 \pm 6.3$  (range: 85 - 100). Accordingly, the outcome was categorized as excellent in six (85.7%) patients and good in one (14.3%) (Table 2).

#### 4.1. Postoperative Complications

The ulnar union was observed in all patients but one (case 7) (Figure 2A). Heterotopic ossification was seen in one patient presented as the calcification of annular ligament (case 5) (Figure 2B). No case of subluxation was seen in our patients during the follow-up evaluations. Moreover, the degenerative joint disease was seen in none of the cases. No other complication was noticed, as well. Accordingly, the radiographic outcome was good in all patients.

## 5. Discussion

The treatment of neglected Monteggia fracture-dislocation is a therapeutic challenge for orthopedic surgeons, as evidenced by the variety of surgical techniques introduced. Moreover, the rates of complication and re-dislocation are high following the surgery of these lesions (14). Although the importance of ulnar osteotomy and radial head reduction is accepted in the treatment of neglected Monteggia fracture-dislocation, there is no consensus on the role of annular ligament reconstruction (3).

Here we evaluated the outcome of neglected Monteggia fracture-dislocation in seven pediatrics treated with ulnar osteotomy, open radial head reduction, and annular ligament repair or reconstruction. At the last follow-up, the mean flexion/extension ROM of the patients was  $137.9^\circ$ . The flexion/extension ROM was not considerably limited in any of the patients. The mean supination and pronation were  $72.1^\circ$  and  $65.7^\circ$ , respectively. The supination was considerably reduced in two patients (cases 5 and 7). Pronation

limitation was observed in three patients (cases 3, 5, and 7). The clinical outcome was categorized as excellent in six patients and good in one. The postoperative complications were a case of heterotopic ossification and a case of ulnar nonunion. Yet, the radiographic outcome was good in all patients according to the aforementioned criteria.

Bhaskar evaluated the outcome of neglected Monteggia fracture-dislocation in 12 children at a mean follow-up of 22 months. Open reduction of the radiocapitellar joint was done for all patients. The ulnar osteotomy was performed for all patients but one. Annular ligament reconstruction was done in five patients. Post-operative ROM was not considerably different between patients who underwent annular ligament reconstruction and those who did not. They concluded that the need for annular ligament reconstruction should be based on the intra-operative findings of radial head instability and ulnar osteotomy suffices in most cases of neglected Monteggia fracture-dislocation (15).

Rahbek et al. compared the outcomes of surgery between 10 neglected pediatric Monteggia fracture-dislocations undergoing ligament reconstruction with ulnar osteotomy and six patients undergoing ulnar osteotomy alone. Based on their results, the radiographic outcome was significantly correlated with the delay in the ulnar osteotomy. However, ligament reconstruction did not influence radiographic or clinical outcomes (16).

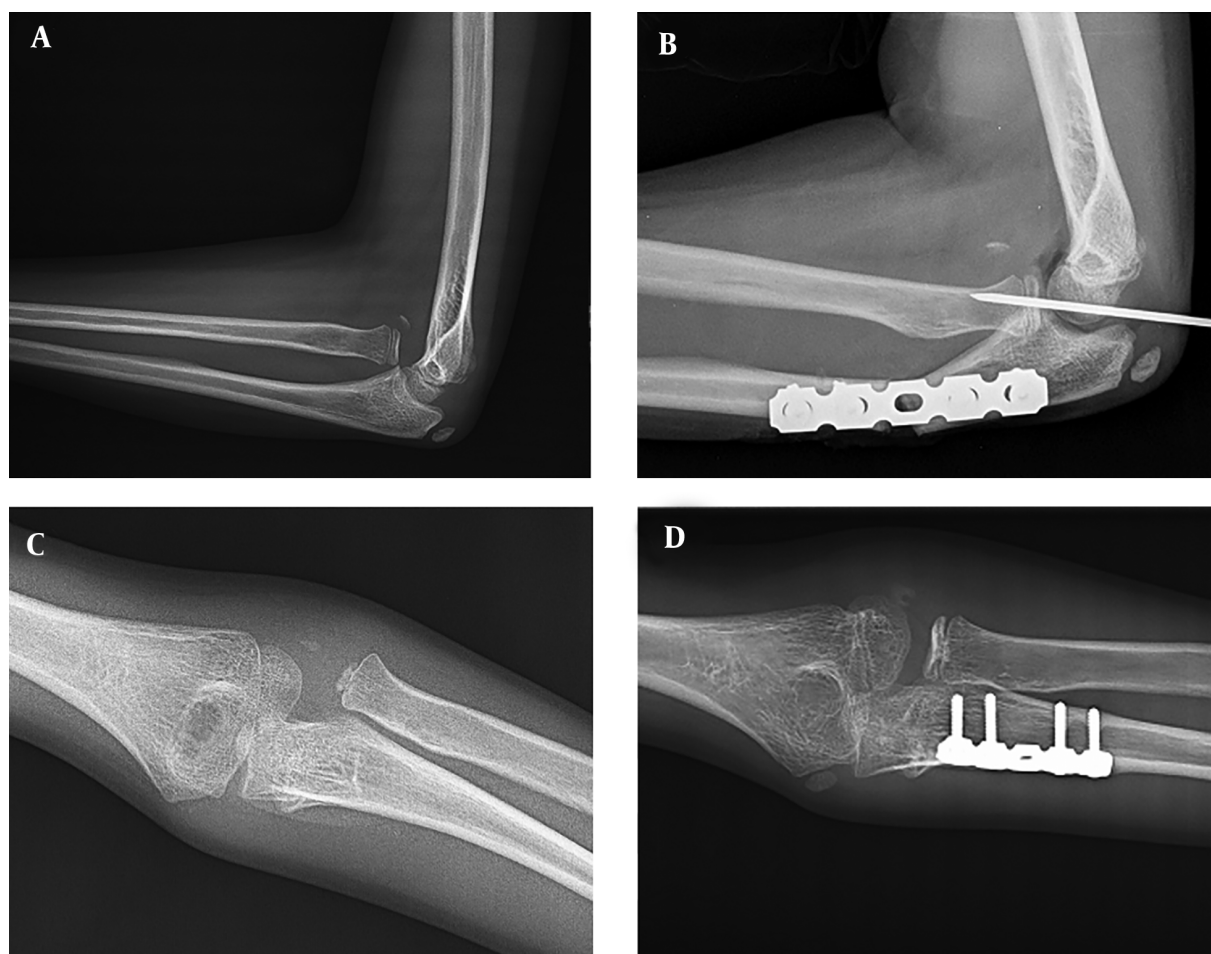
Wang et al. aimed to emphasize the practicality of annular ligament reconstruction in old Monteggia fracture-dislocation through comparing the outcome of surgery in five children who received ulna osteotomy and annular ligament reconstruction and seven cases who received ulna osteotomy without annular ligament reconstruction. Radial head open reduction and internal fixation were done in all cases. Their results demonstrated that ulnar osteotomy has a great significance in keeping the stability of the radial head. However, factors including the time of injury, surgical procedures, and intra-operative radial head stability should be considered in determining the need for annular ligament reconstruction (17).

Eamsobhana et al. evaluated the outcome of 30 pediatric delayed Monteggia lesions treated with open reduction and ulnar osteotomy. Annular ligament reconstruction was done in 23 cases of their series. No statistical comparison was made between the cases with and without ligament reconstruction. However, eight fair/poor radiographic outcomes were recorded in the patients who underwent ligament reconstruction, while no fair/poor radiographic outcome was recorded in the patients for whom annular ligament was not reconstructed (9). Moreover, a fair/poor Kim score was recorded in four patients, all of whom undergoing the annular ligament reconstruc-

**Table 1.** The Clinicodemographic and Surgical Characteristics of Patients with Neglected Monteggia Fracture-Dislocation

ID	Age, y	Gender	Hand Dominance	Delay in Surgery, d	Follow-up, mo	Fracture Type (Bado Classification)	Surgical Approach
1	4.5	Female	Non-dominant	30	34	I	UO, ROR, AL-Rep
2	5.1	Male	Non-dominant	34	70	IV	UO, ROR, AL-Rep
3	6.5	Male	Non-dominant	32	58	I	UO, ROR, AL-Rep, RC pin
4	7.9	Male	Non-dominant	90	30	III	UO, ROR, AL-Rec
5	6.4	Male	Dominant	52	8.5	I	UO, ROR, AL-Rec
6	4	Male	Non-dominant	30	12	III	UO, ROR, AL-Rep
7	11.8	Male	Dominant	105	3	I	UO, ROR, AL-Rep

Abbreviations: AL-Rec, annular ligament reconstruction; AL-Rep, annular ligament repair; RC, radiocapitellar; ROR, radius open reduction; UO, ulnar osteotomy.



**Figure 1.** A preoperative and B, postoperative lateral radiographic view of a Bado type I Monteggia fracture-dislocation; C, preoperative and D, postoperative anteroposterior radiographic view of a Bado type III Monteggia fracture-dislocation. In addition to the main surgeon, two other hand surgeons separately evaluated the radiographs.

tion (9). No fair/poor radiologic outcome was seen in our cohort. Furthermore, the Kim score was not fair or poor in any of our cases.

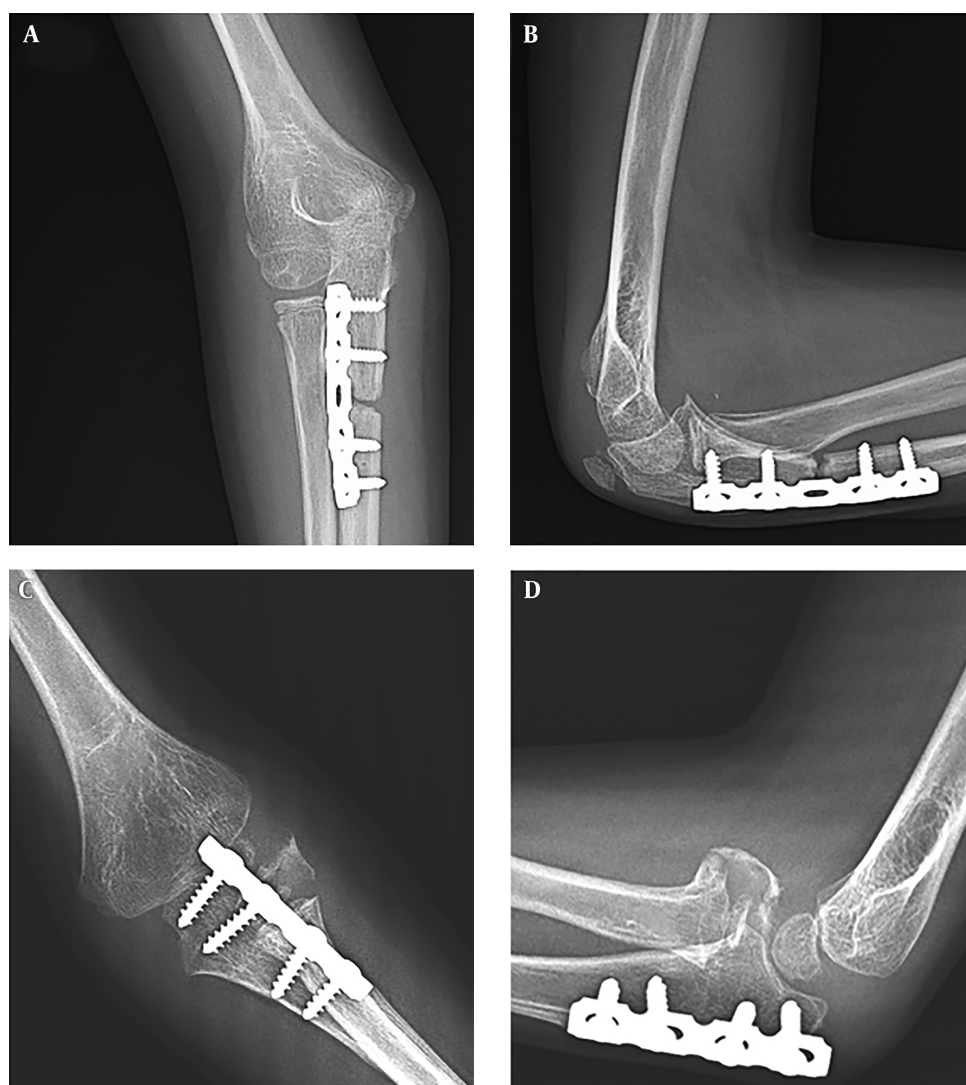
Although we did not compare the outcome of surgery in patients with and without annual ligament approach, our results showed that radial head reduction and ulnar

osteotomy with annular ligament reconstruction or repair result in acceptable outcomes in the management of neglected pediatric Monteggia fracture-dislocation. Similar results were seen in other studies using the same approach (14, 18, 19). The small number of our patients did not allow for any statistical analysis or comparison. Thus, more in-

**Table 2.** The Outcome Measures Following the Surgery of Neglected Monteggia Fracture-Dislocation

ID	Flexion Contracture, °	Flexion, °	Supination, °	Pronation, °	KEPS	Functional Outcome
1	0	135	85	85	100	Excellent
2	0	135	85	85	100	Excellent
3	0	135	90	50	100	Excellent
4	0	140	85	85	100	Excellent
5	0	150	45	30	85	Good
6	10	130	85	85	100	Excellent
7	35	140	30	40	90	Excellent

Abbreviation: KEPS, Kim elbow performance score.



**Figure 2.** A, anteroposterior and B, lateral radiograph of a non-union following the open reduction and ulnar osteotomy with annular ligament repair (case 7); A, Anteroposterior and B, lateral radiograph of a heterotopic ossification following the open reduction and ulnar osteotomy with annular ligament reconstruction (case 5).

investigations are needed to codify the need for annual ligament repair or reconstruction following an old Monteggia

fracture-dislocation.

## Footnotes

**Conflict of Interests :** The authors of this paper declare no conflict of interest to disclose.

**Ethical Approval:** This study was approved by the review board of our institute.

**Funding/Support:** None.

**Patient Consent:** Written informed consent was obtained from the patients' parents before entering the patient in the study.

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