

Case Series

Elbow reconstruction in pediatric missed Monteggia lesions: revisited

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ABSTRACT

Monteggia fractures are unusual injuries in children and adolescents age group wherein the radial head gets dislocated in combination with proximal ulna fractures. Various surgical treatment options are described in the literature to reconstruct these lesions for improvising the limb function. A retrospective study on thirteen patients with missed Monteggia fractures who underwent surgical intervention between 2021 to 2023 at our hospital was done. Patients underwent ulnar distraction angulation osteotomy with or without open reduction of the radial head. Patients were analysed on the visual analogue scale (VAS) for pain; mean VAS 1.9 (range 0 to 5) and functional assessment. There was a significant improvement in rotational movements of the hand after surgery. However, restriction of supination and pronation was observed in 3 patients at the last follow-up. Two patients reported radial head subluxation in last follow-up x-ray out of which one patient has associated elbow stiffness along with the re-dislocation of radial head. Missed Monteggia lesions if identified early can be treated successfully by ulnar angulation osteotomy and reduction of radio-capitellar joint. Good to excellent clinical and radiological outcomes can be expected in those with lesser age and lesser the interval between duration and surgery.

Keywords: Monteggia fractures, Missed, Children, Radial head, Chronic dislocation

INTRODUCTION

Monteggia fractures are relatively uncommon injuries in the pediatric and adolescent population, characterized by dislocation of the radial head in association with fractures of the proximal ulna. These injuries are considered “missed” when radiocapitellar joint subluxation or dislocation persists for more than four weeks following the initial trauma. Such lesions are frequently overlooked in the acute setting due to inadequate radiographic assessment, limited clinical experience, and the presence of ulnar plastic deformation, which may not be readily appreciated on plain radiographs. Chronic radial head dislocation leads to progressive morphological changes, including overgrowth of the radial head and remodeling of the radial notch of the proximal ulna, secondary to loss of joint congruity and restraint. If left untreated, these

changes result in poor long-term outcomes, including pain, stiffness, decreased range of motion, and the development of degenerative arthritis of the elbow.^{1,2} Various surgical techniques have been described for the management of missed Monteggia lesions, with the primary goal of restoring radiocapitellar alignment and improving functional outcomes. These include closed or open reduction of the radial head, transcapitellar pinning, annular ligament repair or reconstruction, and corrective ulnar and/or radial osteotomies.³

Ulnar angulation remains the key source in the reduction of radiocapitellar joint.³ Ulnar distraction and angulation osteotomy cause intrinsic tension in the interosseous membrane which helps in maintaining the radial head in place.⁴ Osteotomized ulna can be stabilized using various surgical techniques and implants. Fixation can be done

using a plate, external fixator, or a combination of these. Complications encountered include re-dislocation or subluxation of the radial head, non-union at the osteotomy site, neurological injury, infections, and other surgery-related complications. We present our series of 13 cases of surgically managed missed Monteggia lesions using angulation distraction osteotomy of the ulna with/ without open reduction of the radio-capitellar joint.

CASE SERIES

We conducted a retrospective study of thirteen patients with missed Monteggia fractures who underwent surgical intervention between 2019 and 2022 at our institution. Demographic and clinical details are summarized in Table I. Of the thirteen patients, eight (61.5%) were male and five (38.5%) were female, with a mean age of 8.7 years (range, 4 to 12 years). The duration from initial injury to presentation ranged from 0.9 to 2.5 years (mean, 1.33 years). Patients presenting with mild to moderate pain, restricted elbow range of motion, or both were included in the study. Exclusion criteria comprised patients with a painless elbow and preserved range of motion, as well as those demonstrating deformity of the radial head or flattening of the capitellum on radiographs. Additionally, patients in whom the radial head was found to be well reduced on elbow flexion during radiographic assessment were excluded and managed conservatively. All patients underwent a detailed preoperative clinical evaluation, including assessment of elbow range of motion. Radiographic evaluation consisted of standard anteroposterior and lateral views of the elbow. On a true lateral radiograph, the radiocapitellar line, drawn along the longitudinal axis of the radial neck and extended proximally, should intersect the middle third of the capitellum in all degrees of elbow flexion. Deviation of this line from the capitellum indicates radiocapitellar subluxation or dislocation, depending on the extent of displacement.^{5,6}

Surgery was executed in supine position under tourniquet control. The skin incision was made directly over the dorsal ulnar border. Subperiosteal dissection was done and the proposed osteotomy site was marked and confirmed on fluoroscopy. Osteotomy site is chosen wherein an adequate proximal ulna is available for fixation with a plate. Osteotomy was done using multiple drill holes with 1.2mm k-wire, and then connecting all the holes using a small osteotome. Dorsal angulation and distraction were done over the ulnar osteotomy site to facilitate radial head reduction. The ulnar osteotomy site was fixed with an arbitrary 20 degrees pre-bent small LC-DCP plate and screws. In some patients where the radial head was not stable enough, temporary fixation of the radiocapitellar joint using a 2 mm k wire was done. No primary bone grafting was done in any of the patients. Open reduction of the Radio-capitellar joint was done if satisfactory alignment and stability was not achieved closely. In three (23%) patients we were able to reduce radiocapitellar joint closely but in the remaining ten (77%) patients open

reduction was done. Annular ligament reconstruction was done in three (23%) patients using triceps fascia graft (Bell tawse procedure). Post-operatively elbow was immobilized for 3 weeks and then gradual mobilization exercises were started. If pinning was done to hold the radial head, it was removed after 3 weeks.

The duration of follow-up ranged from 6 months to 3.5 years, with a mean of 1.8 years. Patients were evaluated postoperatively at 3 weeks and 6 weeks, followed by monthly assessments until restoration of pre-injury functional status. Radiographic assessment was performed preoperatively and at each follow-up visit. Standard anteroposterior and lateral radiographs of the elbow were obtained to evaluate maintenance of radiocapitellar alignment, progression of union at the osteotomy site, and overall joint congruity. Clinical evaluation included measurement of elbow range of motion, specifically flexion, extension, pronation, and supination. Pain intensity was assessed using the Visual Analog Scale (VAS) at postoperative and subsequent follow-up visits. Functional outcomes were evaluated based on the patient's ability to perform activities of daily living, including buttoning a shirt, self-feeding, and combing hair. Patient and caregiver satisfaction with the treatment outcome was recorded at the final follow-up and categorized as satisfactory (S), dissatisfied (DS), or highly satisfactory (HS).

All patients underwent ulnar angulation-distraction osteotomy, with or without open reduction of the radial head. The clinical and functional outcomes are summarized in Table 2. The mean preoperative elbow range of motion included flexion of 108° (range, 90° to 120°), extension of 5.4° (range, 0° to 15°), supination of 37.3° (range, 20° to 60°), and pronation of 37° (range, 30° to 60°). At the final follow-up, the mean elbow range of motion was flexion of 107° (range, 90° to 120°), extension of 4.6° (range, 0° to 30°), supination of 50° (range, 10° to 70°), and pronation of 56.5° (range, 10° to 80°). These findings demonstrate a notable improvement in forearm rotational movements following surgical intervention. However, residual restriction of supination and pronation was observed in three patients at the time of final follow-up.

Pain and functional outcomes were assessed using the Visual Analog Scale (VAS) and evaluation of activities of daily living. The mean preoperative VAS score was 1.9 (range, 0 to 5), which improved to a mean of 1 (range, 0 to 5) at the final follow-up. Functional assessment included the ability to perform routine activities such as combing hair, buttoning a shirt, and self-feeding using the affected limb. Patients were encouraged to perform these activities at each follow-up visit, and their performance was documented. At the time of final follow-up, ten patients were able to perform these activities without difficulty. However, three patients continued to experience limitations in daily activities due to persistent elbow pain and restricted range of motion. Radiographic evaluation

with standard anteroposterior and lateral views of the elbow was performed to assess the stability of the radiocapitellar joint and consolidation at the ulnar osteotomy site. At the final follow-up, two patients demonstrated subluxation of the radial head on radiographs. Of these, one patient also had associated elbow stiffness in conjunction with redislocation of the radial head. Patient and caregiver satisfaction with the treatment outcome was assessed at the final follow-up and categorized as highly satisfied (HS), satisfied (S), or dissatisfied (DS). Eight patients (61.5%) reported being highly satisfied, three patients (23.07%) were satisfied, and two patients (15.38%) expressed dissatisfaction with the outcome

No cases of postoperative infection, radioulnar synostosis, or nonunion at the ulnar osteotomy site were observed. One patient developed posterior interosseous nerve (PIN) neuropraxia, associated with lateral subluxation of the radial head and elbow stiffness. The neuropraxia resolved completely within 16 weeks without the need for surgical intervention. However, the patient continued to have restricted elbow motion with persistent radial head dislocation. Subsequently, at one year following the index procedure, she underwent elbow arthrolysis and radial head excision through a lateral approach.

Table 1: Demographic characteristics, preoperative clinical findings and operative details.

Variables	Values
Age (years), mean±SD	8.7±2.8
Sex	
Male	8 (61.5%)
Female	5 (38.5%)
Duration since injury (years), mean±SD	1.34±0.48
Pain score (VAS), mean±SD	1.92±1.81
Preoperative Range of Motion (degrees), mean±SD	
Flexion	107.7±11.3
Extension deficit	5.8±5.4
Supination	37.7±10.6
Pronation	39.2±10.3
Surgical procedure	
Open reduction	10 (76.9%)
Closed reduction	3 (23.1%)
Radiocapitellar K-wire fixation	
Yes	7 (53.8%)
No	6 (46.2%)
Annular ligament reconstruction (Bell-Tawse procedure)	
Yes	3 (23.1%)
No	10 (76.9%)
Follow-up duration (years), mean±SD	1.83±0.92

Table 2: Summary of postoperative outcomes and complications.

Variables	Values
Flexion at final follow-up	
≥110°	7 (53.8%)
100°–109°	5 (38.5%)
<100°	1 (7.7%)
Extension lag at final follow-up	
≤5°	11 (84.6%)
>5°	2 (15.4%)
Supination at final follow-up	
≥60°	7 (53.8%)
30°–59°	3 (23.1%)
<30°	3 (23.1%)
Pronation at final follow-up	
≥60°	9 (69.2%)

Continued.

Variables	Values
30°–59°	2 (15.4%)
<30°	2 (15.4%)
Pain (VAS score)	
0–2	11 (84.6%)
>2	2 (15.4%)
Functional outcome	
Able to comb hair	11 (84.6%)
Able to button shirt	11 (84.6%)
Able to self-feed	10 (76.9%)
Radiological outcome	
Postoperative elbow subluxation/dislocation	2 (15.4%)
No postoperative subluxation/dislocation	11 (84.6%)
Complications	
None	9 (69.2%)
Restricted supination/pronation	2 (15.4%)
Restricted flexion-extension arc	1 (7.7%)
PIN neuropraxia	1 (7.7%)
Patient satisfaction	
Highly satisfied	8 (61.5%)
Satisfied	3 (23.1%)
Dissatisfied	2 (15.4%)

*Values are presented as the number of patients, with the percentage in parentheses. VAS=Visual Analog Scale; PIN=posterior interosseous nerve.



Figure 1: Pre-operative x-ray image.



Figure 3: The x-ray image of patient at 6-month follow-up.



Figure 2: Post-operative x-ray image.

DISCUSSION

Monteggia fractures are frequently overlooked at the time of initial injury, with missed diagnoses reported in nearly 30% of cases.^{7,8} When identified acutely, these injuries typically require open reduction of the radiocapitellar joint along with restoration and maintenance of ulnar length. Despite appropriate initial management, up to 20% of acutely treated Monteggia fracture-dislocations may subsequently lose reduction, necessitating further intervention.^{7,9} Missed Monteggia fractures commonly present later with mild to moderate pain, instability, and elbow stiffness.^{7,10,11} Chronic dislocation of the radial head further exacerbates functional impairment, particularly affecting forearm rotation due to progressive deformity of

the radial head.¹² Various treatment strategies have been described in the literature for such neglected injuries, with most studies favouring surgical intervention over conservative management.^{11,13,14} Surgical treatment is generally advocated to restore joint congruity, improve function, and reduce the risk of long-term complications such as degenerative arthritis. In this study, we aimed to evaluate the functional and radiological outcomes, as well as patient satisfaction, following surgical management of missed Monteggia lesions in children.

Total of thirteen children with missed Monteggia lesions were enrolled in our study; 61.5 % males and 38.5% females with mean age of 8.7 years (4-12 years). Mean time duration since initial injury was 1.33 years ranging from 0.9 years to 2.5 years. Eamshobhana et al did study on 30 patients with missed Monteggia lesions; 60 % were boys and 40 % girls with a mean age of 7.4 years (range 4-13 years).¹⁵ The mean interval from initial injury to surgery was 23 months. Another study conducted by Shu Cao et al. on 29 patients with missed Monteggia lesions, 69 % were male and 31 % were female patients with a mean age of 7 years (range 1-13 years).¹ The mean interval between injury and surgical treatment was 11 months. Our study population is comparative with the present studies in terms of male dominance, age of presentation and duration since initial injury.

The maximum age at which successful reduction of the radial head can be achieved without compromising elbow function remains variable in the literature. In our series, three children older than 10 years (patients 7, 8, and 12) demonstrated restricted elbow movements postoperatively. In contrast, one child (patient 11), aged 12 years at the time of surgery, achieved good functional and radiological outcomes without any abnormalities. Additionally, one child (patient 2), who presented at 8 years of age, developed restricted elbow motion along with posterior interosseous nerve (PIN) neuropraxia. Previous studies have proposed differing thresholds for successful intervention. Stoll et al. reported that reduction may be successful up to four years after injury and suggested 10 years as the upper age limit for achieving favorable outcomes of the radiocapitellar joint.¹⁶ Wang et al recommended a shorter interval of up to three years post-injury for optimal reduction of the radial head.¹⁷ Wilkins, on the other hand, suggested that reconstructive procedures should preferably be performed in patients younger than 12 years.¹⁸ Based on our findings and existing literature, an age of around 10 years may be considered a reasonable upper threshold for achieving optimal outcomes in radiocapitellar joint reconstruction. However, delayed presentation alone should not preclude surgical intervention, as satisfactory results may still be obtained in select older children.

Ulnar length has been considered an important factor affecting the functional outcomes. Radius and ulna act as a single unit during pronation-supination movements. Therefore, ulnar osteotomy plays an important role in

management of missed Monteggia lesions.¹⁴ Various osteotomies are described in the literature for correction of such deformities such as ulnar bending osteotomy, ulnar rotation osteotomy, combined ulnar bending plus lengthening, combined ulnar lengthening plus radial shortening osteotomy. The aim of all these procedures is to create a tension in interosseous membrane which keeps radial head reduced in position. Proximal ulna is preferred site for osteotomy as the resulting scar and altered bone shape is less bothersome to the patient. Various methods for fixation of ulnar osteotomy are described in literature including fixation with a plate, k wires, external fixator or combination of these implants.^{3,19,20} In our study we did angular ulnar distraction osteotomy in all patients and fixed with an arbitrary 20 degrees pre-bent plate.

There are several studies in literature reporting successful reduction of radial head with just ulnar osteotomy without requiring open reduction in missed Monteggia lesions.²¹⁻²³ Many authors recommend open reduction, ulnar osteotomy with or without annular ligament reconstruction.^{17,20,24,25} In our study we attempted closed reduction after ulnar osteotomy in all the patients, and stability was assessed. In patients with unstable joint, decision for open reduction was taken. In 3 children (patient 1, 4 and 13) radial head was found stable hence the joint was not opened, while in rest ten (76.9%) patients open reduction of joint was done. The three patients in whom closed reduction was successfully achieved with good results postoperatively, were aged less than 7 years with average 1 year of duration since injury. Hence, we believe that lesser the age of child with lesser duration since injury, can promise good results after surgical intervention.

Some authors advocate to reconstruct annular ligament always when the radiocapitellar joint is opened.^{5,26} In these long-standing chronic dislocations direct repair of the ligament is not possible. Various methods are documented in literature for annular ligament reconstruction (ALR) using forearm fascia, triceps fascia and the palmaris longus graft. Rahbek et al in their study reported no difference in outcomes after ulnar distraction osteotomy with or without ALR.²⁷ In a case series of 12 cases, Bhasker concluded that annular ligament reconstruction is not always necessary and should be considered based on intraoperative findings; if radial head remains unstable, ALR is recommended.²⁴ In our study we did ALR in 3 patients using Bell Tawse procedure. If radial head remains unstable after ulnar osteotomy the trans-capitellar radial head fixation using a k-wire should be done.²⁶ In our study we used a k-wire to fix radiocapitellar joint in 7(53.8 %) patients. Based on our study we believe that ALR and trans-capitellar k wire fixation is not always required and should only be done based on intraoperative findings.

One patient developed post-operative neuropraxia of posterior interosseous nerve. Observation and conservative management were chosen for neuropraxia, which got recovered completely in about 6 months. Due to persistent

radial head dislocation with radiocapitellar arthritis and restricted elbow functions, radial head excision was done after one year. None of the patients developed infection, non-union at osteotomy site.

Limitations

Strength of the evidence is limited by several factors, including the small sample size of 13 patients, the retrospective study design, heterogeneity in surgical techniques, and variable duration of follow-up. As patients were managed with differing combinations of open reduction, K-wire fixation, and annular ligament reconstruction, it is challenging to delineate the individual contribution of each component to the overall outcome. Furthermore, the use of non-standardized functional assessment tools and subjective satisfaction categories restricts direct comparison with existing literature. Prospective studies with larger sample size and long follow ups are needed to understand the patient centered outcomes and impact on quality of life.

CONCLUSION

Overall, the study provides valuable observational insights; however, the conclusions should be interpreted with caution in view of the study's methodological limitations. Missed Monteggia lesions, when identified early, can be effectively managed with ulnar angulation osteotomy and reduction of the radiocapitellar joint. The need for adjunctive procedures such as open reduction, annular ligament reconstruction, and transfixation of the radiocapitellar joint should be determined intraoperatively based on individual case findings. Favorable clinical and radiological outcomes are more likely in younger patients and in those with a shorter interval between injury and surgical intervention.

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