

Case Series

Step-cut, biplanar, elongation and angulation ulnar osteotomy with annular ligament reconstruction in neglected Monteggia fracture dislocation in children: a retrospective study

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ABSTRACT

Monteggia fracture dislocation is an infrequent injury in children, with around 20-50% cases being missed on initial consultation; leading to their chronic and neglected forms leading to number of complications; thus justifying their operative management. Various treatment modalities have been suggested in the literature for these neglected injuries. A retrospective study of 7 patients (5 males and 2 females), with mean age of 9.58 years (7-14 years); with neglected Monteggia fracture dislocation undergoing corrective reconstructive surgery in the form of elongation and angulation proximal ulnar osteotomy with radial head reduction combined with annular ligament reconstruction was conducted and was then evaluated clinically and functionally using Mayo Elbow Performance Index (MEPI) score; and radiographically were graded as good, moderate or poor. The mean interval from time of injury to the time to corrective surgery was 10.58 weeks (range 6-16 weeks). The mean improvement in the post operative MEPI score was 23.57. The mean improvement in the post operative flexion-extension arc was 28.57°, while that in the supination-pronation arc was 20.72°. We concluded that Step-cut, biplanar, elongation and angulation proximal ulnar osteotomy with additional reinforcement in the form of annular ligament reconstruction is an effective technique to treat neglected Monteggia fracture dislocations in children; having excellent clinical, functional and radiological outcomes.

Keywords: Monteggia fracture, Step-cut, Biplanar, Elongation, Annular ligament reconstruction

INTRODUCTION

Monteggia fracture, involving the forearm and the elbow joint with fracture of the proximal ulna shaft and dislocation or subluxation of proximal radioulnar joint, was first described by Giovanni Battista Monteggia in 1814.¹⁻² These injuries if diagnosed early, can be well managed conservatively by close reduction and cast immobilization. However, in cases where the stable reduction of the ulna shaft fracture or the radial head dislocation cannot be done by closed means, surgery is

indicated.³ It has been observed that ulna shaft fracture is diagnosed correctly, but the radial head dislocation is often missed by many clinicians; thus making the treatment at a later date difficult.⁴ Moreover, isolated fracture of proximal ulna shaft in absence of radial head dislocation / subluxation is a very rare injury to be encountered in children.⁵ Similarly isolated radial head dislocation / subluxation in absence of plastic deformation of ulna shaft (often missed) is a very rare injury of childhood.⁶ In these patients, going ahead with strengthening the physiological

curve of ulna, will prevent the reduction or will lead to incomplete reduction of the radial head.⁵⁻⁸

In the past there have been many studies which have shown re dislocation of the well reduced radial head or late dislocation in patients with initial good radiographs.⁹ Dislocation of the radial head is considered to be chronic after 4 weeks.¹⁰ As per the literature as much as 33% of the original Monteggia fractures are missed on initial encounter and around 20% of these injuries suffer late loss of reduction after being given initial conservative treatment; thus leading to chronic forms.¹¹ Such chronic dislocations poses a challenge to an orthopedician and are very difficult to treat by closed means; and have been described in the literature as an indication for surgical treatment.¹² Chronic Monteggia fracture dislocation can lead to number of complications like premature arthritis, palpable mass, instability, decreased range of elbow motion, valgus deformity and late (tardy) ulnar nerve palsy.¹³⁻¹⁷ Many treatment modalities have been advised in the literature for these neglected and chronic Monteggia fracture dislocations in children like open reduction of radial head with or without repair or reconstruction of the annular ligament, various ulnar lengthening or radial shortening osteotomies; as well as various combinations of these modalities.^{16,18-22} Recently, gradual lengthening and angulation of ulna shaft with gradual closed reduction of radial head using external fixators like Ilizarov have been described as one of the ways to treat these chronic lesions.^{12,23}

CASE SERIES

We did a retrospective study reviewing 7 patients of neglected Monteggia fracture dislocation treated at Bharatratna Doctor Babasaheb Ambedkar Municipal Hospital (tertiary center) from 2017 to 2023. The study was conducted after getting approval from the institutional ethical committee; with the help of hospital records, operative notes and details, follow up records and radiographs.



Figure 1: Pre operative anteroposterior; A) lateral, B) radiographs showing anterolateral dislocation of the radial head with plastic deformation of the ulna.

All the patients presented to us after minimum of 4 weeks interval from the time of injury; thus correctly labeling them as neglected Monteggia fracture dislocation, as per the literature.^{10,23,24}

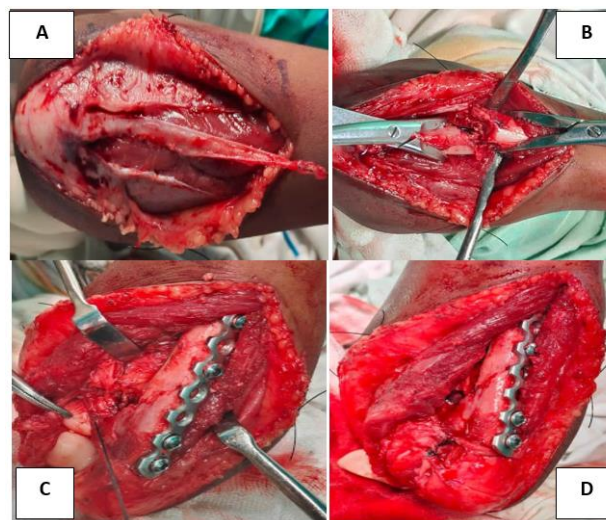


Figure 2: Intra operative images showing triceps fascial aponeurosis being harvested for annular ligament reconstruction by Bell-Tawse technique; A) step-cut, biplanar, elongation and angulation osteotomy being done at proximal metaphyseal ulna; B) osteotomy site fixed with plate after ensuring stable radial head reduction; C) harvested fascial strip wound around the radial neck; D) thus reconstructing the annular ligament by Bell-Tawse technique.

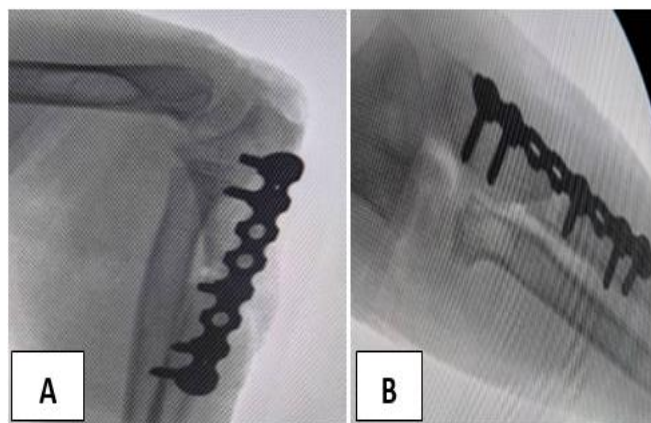


Figure 3: C arm photos taken during surgery; A) Lateral and B) anteroposterior.

All the patients included in the study had minimum of 12 months follow up records. All the patients had Bado type 1 injury with malunited proximal ulna shaft fracture and anteriorly dislocated radial head, without any neurovascular compromise or any other associated injury. All the patients were then evaluated radiographically, functionally and clinically. Functional and Clinical evaluation was done with the help of Mayo elbow

performance index (MEPI) score, which includes maximum of 100 points; consisting of 4 parameters; pain,

elbow range of motion, elbow stability and performance of daily activities.

Table 1: Depicts the Demographic details of the study population.

Case number	Sex	Side	Age at Surgery (years)	Time interval from Injury to Surgery (weeks)	Time for Osteotomy site to heal (weeks)
1	Male	Right	7	6	8
2	Male	Left	6	10	8
3	Male	Left	12	12	12
4	Female	Right	11	8	12
5	Male	Left	14	16	12
6	Male	Right	9	10	8
7	Female	Right	8	12	8

Table 2: Depicts the Clinical, Functional and Radiological outcomes of the study population.

Case no.	Radiographic result	Elbow Flexion/Extension Arc (°)			Forearm Supination/Pronation arc (°)			MEPI	
		Pre operative	Post operative	Change	Pre operative	Post operative	Change	Score	Result
1	Good	105/10	135/0	40	60/65	70/80	25	100	Excellent
2	Good	110/0	130/0	20	60/70	65/85	20	95	Excellent
3	Good	105/20	130/0	45	50/60	65/70	25	95	Excellent
4	Good	100/10	120/0	30	60/70	65/85	20	100	Excellent
5	Good	90/20	100/20	10	50/50	50/65	15	80	Good
6	Good	105/10	130/0	35	70/80	85/85	20	100	Excellent
7	Good	110/0	130/0	20	65/70	70/85	20	100	Excellent

MEPI score of 90-100 is considered as excellent, 75-89 is good, 60-74 is fair and less than 60 is poor result.^{25,26} The radiographic results were graded as good (complete reduction of the radial head with no arthritic changes), moderate (persistent subluxation and/or arthritic changes) and poor (complete dislocation of the radial head) as described by Delpont et al.¹⁹

Table 3: Depicts the summary of results.

Parameters	Observations
Number of Subjects	7
Mean age (years)	9.58
Mean interval from Injury to Surgery (weeks)	10.57
Mean increase in Flexion/Extension Arc	28.57°
Mean increase in Supination/Pronation Arc	20.72°
Mean increase in MEPI score	23.57
Mean duration of union of osteotomy site (weeks)	9.71

The surgery was performed under general anesthesia with the patient in lateral position, and arm supported on lateral bolster.

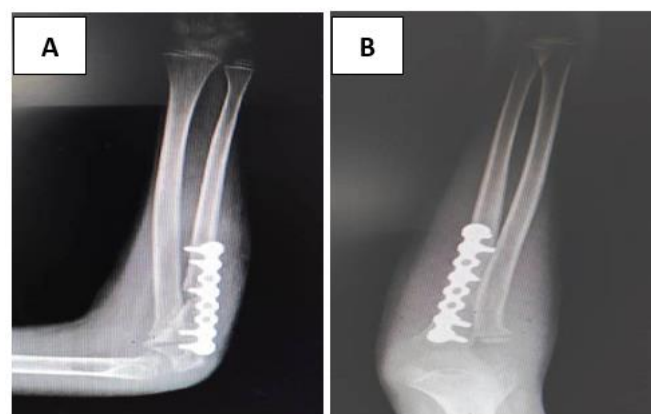


Figure 4: Radiographs taken after 4 weeks of surgery; A) Lateral and B) anteroposterior.

An extensile posterolateral elbow approach via Kocher's interval was done in all the patients, which enabled us to have open reduction of the radial head along with step cut osteotomy of the proximal ulna shaft with annular ligament reconstruction using triceps fascia (Bell-Tawse

technique).²⁰ The step cut osteotomy of the proximal ulna shaft was sagittally oriented Z - shaped type with one longitudinal and two horizontal limbs with respect to the ulna shaft.

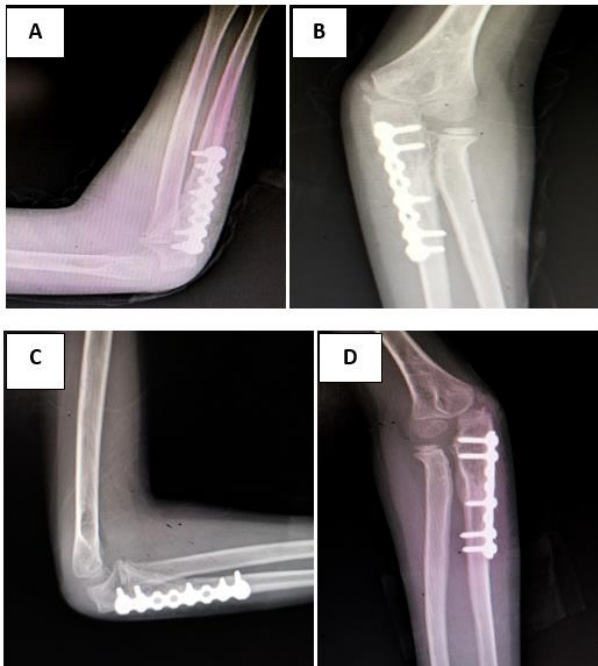


Figure 5: Lateral (A, C) and anteroposterior (B, D) radiographs taken at 3rd month (A, B) and 6th month (C, D) post surgery, showing complete healing of the osteotomy site with stable reduction of the radial head.

Osteotomy was done in the metaphyseal region in the proximal ulnar shaft, and was lengthened and angulated anteriorly which enabled the reduction of radial head. The lengthening and angulation was adjusted as per the stable reduction of the radial head. In all cases the osteotomy site was fixed with a plate without bone grafting. The annular ligament was reconstructed in all the cases using the central slip of triceps fascial aponeurosis, taking care to preserve its attachment to the olecranon, similar to Bell-Tawse technique.²⁰ The fascial slip was then passed around the radial neck and sutured on itself. The patients were immobilized in above elbow slab in mid prone position for the period of 2 weeks. After the slab removal, mobilization was begun as tolerated, with resistance training started after full active and passive range of motion achieved; and sporting activities begun after the radiographs showed signs of union at the osteotomy site. All the patients were followed up at 2nd and 6th week and then at 3rd, 6th and 12 month after the surgery; where their radiographs were taken and clinical and functional assessment done with MEPI score.

There were 7 patients (5 males and 2 females) with the mean age being 9.58 years (range 7-14 years); with 4 right sided and 3 left sided injured limbs. The mean interval

from time of injury to the time to corrective surgery was 10.58 weeks (range 6-16 weeks).



Figure 6: Complete range of motion achieved at 3rd month post surgery.

All the patients were followed up to minimum of 12 months from the time to corrective surgery. All the patients had stable reduction of the radial head and good union of the osteotomy site on all the follow ups radiographs. The mean time to union of the osteotomy site as evident on the radiographs was 10 weeks (range 8-14 weeks). No neurovascular compromise and infection was seen in any of the patients.

Out of the 7 patients included in the study, 6 had excellent MEPI score, while only 1 patient had good results. This one patient who had good clinical and functional outcome as per MEPI scoring system, presented to us after 16 weeks of injury after taking initial treatment from the quack in the form of massage and bandaging, with no effect. Also pre operatively his flexion-extension and supination-pronation elbow arc was less than other 6 patients. Intra operatively he had much fibrous tissue and heterotrophic ossification around the elbow joint; the radio capitellar joint in particular, which was thoroughly debrided, ulnar shaft osteotomised and the radio capitellar joint was then reduced. Post operatively also this patient had flexion-extension and supination-pronation elbow arc less as compared to the other patients. Based on the MEPI scoring system, the mean pre operative score of the patients was 72.15; while that on the final post operative follow up (at 12th month) was 95.72; with mean increase in the MEPI being 23.57. The mean flexion-extension elbow arc pre operatively was 93.57°; while the mean supination-pronation arc was 125.72°. The mean flexion-extension elbow arc post operatively at the last follow up was 122.14°; while the mean supination-pronation arc was 146.43°.

DISCUSSION

Monteggia fractures are uncommon injuries in the children; with around 20-50% of the cases either being undiagnosed or misdiagnosed on the initial consultation.⁹ Most commonly the radial head dislocation is missed because the focus being mainly on the ulna shaft fracture, which itself is a very rare injury to be encountered in children.⁵ Another reason of neglect in these injuries is failure to diagnose the plastic deformation of ulna shaft with radial head dislocation, known as Monteggia variant.^{6,9} These variants are usually post traumatic in nature and should be differentiated from the congenital radial head dislocations which are usually bilateral in nature and are associated with dysplasia of radial head and capitellum; whereas these variants occur due to traumatic ulnar bowing.^{6,8,27} Apart from being misdiagnosed, in developing countries many parents opt for non orthopedic quack management initially; which again leads to chronicity of the condition. There are number of problems associated with these neglected Monteggia fracture dislocations like; decrease in the elbow flexion-extension and supination-pronation arc, cubitus valgus deformity, elbow instability, pain, late ulnar neuropathy, cosmetic deformity and subluxation of the distal radio-ulnar joint (Essex-Lopresti lesion).^{15,28-30} As the time progresses, the radio-capitellar articulation begins to undergo dysplastic changes; whereby the concave radial head articulating with capitellum starts flattening out and starts displaying heterotrophic malformations, while the capitellum starts showing hypoplastic changes; leading to restricted range of elbow motion.^{14,18} As the radial head remains anteriorly dislocated, it leads to loosening of the tension of the introsseous membrane, thus leading to recurrent dislocation even if close reduction is attempted.¹⁴ This needs open reduction with ulnar lengthening to tension the introsseous membrane so as prevent recurrent dislocation.

In study conducted by De Gennaro et al it has been concluded that there is no scope for wait and watch in cases of neglected Monteggia fracture dislocations; and these injuries need operative management upfront.¹⁵ However, there is still no consensus regarding operative management protocols of neglected Monteggia fracture dislocations. Some studies have shown the surgery should be directed towards the radio-capitellar joint, with open reduction and joint debridement with annular ligament excision.^{14,19,21} Some studies have found ulnar osteotomy with correction or overcorrection of the ulnar bow with reduction of the radial head to be the preferred surgical treatment.^{5,14,16,24,31} However, overcorrection of the ulna bow is associated with cosmetic deformity.³² Some studies have shown gradual ulnar lengthening with radial head reduction with the help of external fixators as the preferred treatment method for long standing neglected Monteggia dislocation.^{12,23,32,33} In study conducted by Chen et al it was concluded that radial shortening osteotomy along with ulnar lengthening osteotomy had better results to tension the introsseous membrane and keep radial head in well reduced position.³⁴

All the patients in our study had malunion of the ulna fracture, which was preventing the reduction of the radial head.^{11,13,21} The surgical technique we performed consisted of a Z-shaped angulation and elongation step cut ulnar osteotomy at the metaphyseal region, which enabled stable reduction of the radial head with tensioning of the introsseous membrane.¹⁴ The osteotomy site was then fixed internally with a plate only after achieving adequate lengthening and angulation as desired to have stable radial head reduction. The osteotomy site being in the metaphyseal region and step cut one, increases the surface area between the bony ends and enhances stability and union rates. This type of angulation and elongation osteotomy has been described by Bouyala.³⁵ Hasler et al in his study also made use of angulation and elongation ulnar osteotomy to reduce the radial head, which was later fixed internally with a plate only after stable reduction was achieved.³⁶ Hasler et al stated that only stable repositioned radial head is capable of defining the appropriate position for ulnar realignment.³⁶ The biplanar osteotomy to correct the complex deformity has been described by Kim et al and Delpont et al in their respective studies, who concluded that the ulnar deformity and bowing responsible for recurrent dislocation of radial head is usually complexly biplanar.^{19,37}

The age and the time interval from injury at which such neglected cases should be operated with success, is also a matter of debate in the literature. Freedman et al, reported a case where he achieved a stable surgical reduction after 6 years of the initial trauma.³⁸ Ladermann et al in his study concluded that, performing proximal ulnar osteotomy in such neglected cases helps to achieve a successful reduction even after 7 years of initial insult.¹⁴ In study by Hirayama et al and Stoll et al, it was found that stable reduction of the radial head was achieved in a 10 years old child even after being operated 4 years after the initial insult.²¹ Horii et al concluded that stable reduction can be achieved if the patients are operated up to 12 years of age.¹¹ This was based on the theory that, before 12 years of age there is excellent potential of remodeling and the soft tissues being flexible the problem of joint stiffness does not occur.^{30,39} However, at the same time longer the time interval from initial trauma to the reconstructive procedure; the success rates may decrease depending upon the degree of dysplastic changes happening at the elbow.

Annular ligament reconstruction is another controversial topic in the management of these neglected cases, with some authors favoring it while others finding it unnecessary procedure and disregarding it completely. Nakamura and David-Wes, in their studies recommended annular ligament reconstruction in all the cases while Devani and Laderman negates its usefulness completely. Bhaskar et al, in his study recommended an intra-operative decision to be taken on reconstruction depending on the stability of radial head reduction.^{9,18,40,41} In all our cases we reconstructed the annular ligament, taking triceps fascial aponeurosis graft as per the Bell-Tawse technique; although Garg et al recommends better results with the use

of Palmaris longus graft.⁴² Annular ligament reconstruction, however needs an additional dissection which at a later date might lead to elbow stiffness, heterotrophic ossification, avascular necrosis of the radial head or proximal radio-ulnar synostosis.⁴¹ Recurrence of the radial head dislocation after ulnar osteotomy, is due to improper lengthening and angulation of the osteotomy site rather than annular ligament reconstruction. We added the annular ligament reconstruction procedure as an additional check in to prevent recurrent dislocation, though there was stable reduction of the radial head in all our cases even before the reconstruction of the annular ligament.

The clinical and functional evaluation was done with the help of Mayo Elbow Performance Index (MEPI) and the results were comparable with those of Nakamura, Delpont and Datta.^{18,19,25} However, other scoring systems like Kims's elbow performance score, the Oxford elbow score and modified DASH score also have been used by many authors to evaluate the outcomes in the neglected Monteggia fracture dislocation cases managed surgically.^{9,15,43} The preliminary report regarding treating these neglected Monteggia fracture dislocation cases with open reduction of radial head with step cut biplanar, elongation and angulation proximal ulnar osteotomy with annular ligament reconstruction; was published in Rajsekaran et al.⁵ They concluded all the patients treated by this novel technique to have excellent post operative outcomes. Our study gives additional strength and support to this preliminary report.

Limitations

However, there were few limitations in our study. First, the sample size was small which can be considered due to rarity of this injury. Other published literatures also had the same limitation. Only few published studies had larger sample size, where the study was a multicenter type. Second, all the patients included in the study had Bado type 1 injury. Third, the follow up period was short. We would like to have a prospective and multi center study in future with larger sample size and longer follow ups; including other Bado lesions as well to have a better intra group comparative evaluation and draw conclusions regarding the treatment protocols for this rare injury.

CONCLUSION

Early detection of the injury with special attention to the configuration of proximal radio-ulnar joint and prompt treatment; with either close reduction and serial follow up radiographs to confirm the reduction or operative management either if the reduction cannot be achieved at the first instance or loss of reduction at a later date; helps to prevent these cases going into chronic and neglected forms, which are a challenge to treat for an orthopedic surgeon. Various treatment protocols have been advised in the literature. In our study we found open reduction of the radial head with joint debridement (in cases where fibrous tissue was found to hamper the radial head reduction),

proximal metaphyseal ulnar biplanar, elongation and angulation osteotomy (step-cut osteotomy) with internal fixation with a plate after stable radial head reduction was achieved, and annular ligament reconstruction using Bell-Tawse technique; to be an effective and rewarding technique to manage these neglected Monteggia fracture dislocation cases. However, in severely long-lasting chronic dislocations with overgrowth of radius, gradual reduction of radial head with gradual lengthening of ulna and using external fixator should be considered rather than shortening osteotomy of radius alone.

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