

# Functional Outcome of Bell Tawse Procedure for the Management of Chronic Unreduced Monteggia Fracture-Dislocation in Children

## Abstract

**Aim of Study:** Unreduced or missed Monteggia fracture-dislocation after 4 weeks is a common presentation in a tertiary care center. The aim of this study is to study the functional outcome of Bell Tawse procedure for the management of chronic unreduced Monteggia fracture-dislocation in children. **Materials and Methods:** In this retrospective study with prospective data collection, 17 children were treated with open reduction of the radial head and annular ligament reconstruction (Bell Tawse) combined with ulnar osteotomy. The cases were classified based on Bado's classification. The minimum period of followup was 14 months and maximum followup was 18 months with the mean period of followup of 16.2 months. Preoperative and postoperative Mayo Elbow Performance Index (MEPI) scores were calculated. We also compared the preoperative and postoperative Kim's elbow functional scores. **Results:** At the final followup, the radial head was maintained in a completely reduced position in 16 children. Mean preoperative MEPI score was 76.76 and mean postoperative score was 91.11, which was statistically significant ( $P < 0.001$ ). Mean preoperative Kim's score was 76.94 and mean postoperative score was 91.35, which was also statistically significant ( $P < 0.001$ ). One girl had a mild subluxation of the radial head at 1-year followup. The ulnar osteotomy was united in all 17 children, and none of them required secondary procedures. We have not identified any complications such as compartment syndrome, infection, posterior interosseous nerve palsy, avascular necrosis of the radial head, or loss of range of motion. **Conclusion:** We recommend ulnar osteotomy, open reduction of the radial head, and annular ligament reconstruction in children with unreduced Monteggia fracture-dislocation before long term complications sets in.

**Keywords:** Annular ligament reconstruction, Bell Tawse, cubitus valgus, radial head dislocation, unreduced Monteggia fracture

**E G Mohan Kumar,  
G M Yathisha  
Kumar,  
Mohammed  
Noorudheen**

Department of Orthopedic  
Surgery, KIMS Al Shifa  
Hospital, Perinthalmanna,  
Kerala, India

## Introduction

Unreduced or missed Monteggia fracture-dislocation after 4 weeks is a common presentation in a tertiary care center, especially in India. The most common reason is misdiagnosis at primary presentation and failure to identify the radial head dislocation. Usually, these children notice deformity after 2 months of injury while mobilizing the elbow after initial immobilization. These children present with instability, progressive deformity of the elbow usually valgus deformity, and in few cases, tardy ulnar nerve palsy.<sup>1-4</sup>

Delayed recognition of a Monteggia fracture continues to pose a treatment challenge, as evidenced by the numerous surgical techniques that have been described. The various procedures include ulnar and radial osteotomies, open or closed reduction of

the radial head, repair or reconstruction of the annular ligament, temporary fixation of the radial head with a transarticular wire, or some combination of these techniques.<sup>3,5-17</sup> Numerous complications of such procedures have been reported which include subluxation and redislocation, stiffness, elbow instability, nonunion of the osteotomies, avascular necrosis (AVN) of the radial head, nerve injury, degenerative arthritis, and infection.<sup>9,11,16,18-22</sup>

The objective of our retrospective study was to evaluate the clinical and radiological outcomes of patients who were treated with Bell Tawse procedure (ulnar osteotomy and radial head open reduction and annular ligament reconstruction).

## Materials and Methods

This retrospective study with prospective data collection was approved by our hospital ethical committee. 21 children

### Address for correspondence:

Dr. G M Yathisha Kumar,  
Department of Orthopedic  
Surgery, KIMS Al Shifa  
Hospital, Perinthalmanna,  
Kerala, India.  
E-mail: yathishishere@gmail.  
com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

**How to cite this article:** Mohan Kumar EG, Yathisha Kumar GM, Noorudheen M. Functional outcome of bell tawse procedure for the management of chronic unreduced monteggia fracture-dislocation in children. Indian J Orthop 2019;53:745-50.

### Access this article online

Website: www.ijoonline.com

DOI:  
10.4103/ortho.IJOrtho\_47\_19

### Quick Response Code:



with neglected Monteggia fracture were treated with ulnar osteotomy and open reduction of the radial head along with reconstruction of annular ligament (Bell Tawse). The study period was between July 2010 and July 2017. Children who presented at least 2.5 months after injury were included in the study. Patients who lost followup were excluded. The cases were classified based on Bado's<sup>23</sup> classification. Indication for surgery was children with unreduced radial head dislocation with malunited ulna fracture and progressive valgus deformity. All patients had a history of trauma involving the ipsilateral elbow or forearm and were treated with Plaster of Paris immobilization or indigenous management or splinting and referred from other hospitals. All 21 children complained of deformity associated with instability of elbow, few children had limitation of range of motion of elbow and none of the patients had signs of neuropathy or a history of previous elbow surgery. A total of 21 cases were operated during this period and complete follow was available in 17 children with 11 boys and 6 girls, the remaining 4 cases were lost to follow-up. The minimum period of followup was 14 months and maximum followup was 2 years with the mean period of followup of 16.2 months. The mean age of the patients at operation was  $6.61 \pm 1.49$  years. The right elbow was involved in 10 patients and the left was injured in 7. The mean interval from injury to surgery was 3.52 months (range between 3 and 5 months). None of the children had preoperative ulnar nerve palsy.

All patients were checked for elbow pain, the range of elbow movement, carrying angle, valgus instability, and any disabilities in daily life [Figure 1a-c]. Preoperative and postoperative Mayo Elbow Performance Index (MEPI) scores were calculated from the data in the medical records for all patients.<sup>24</sup> We also compared the preoperative and

postoperative Kim's elbow functional scores.<sup>25</sup> The Kim's index is based on four parameters: deformity, pain, the range of motion, and function. These four parameters are weighted equally, giving 25 points to each parameter, for a total score of 100 points.<sup>26</sup>

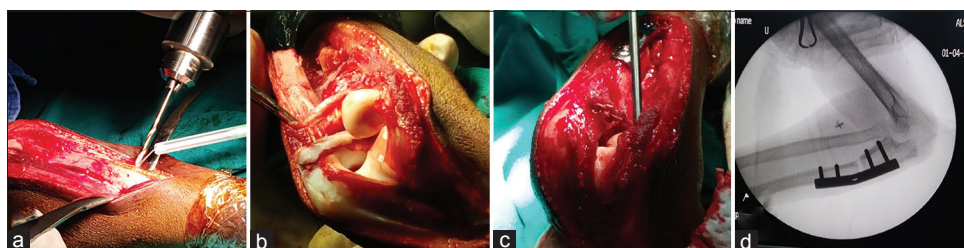
All radiologic measurements were performed including deformity of the radial head, osteoarthritic changes, and congruency of the radiocapitellar joint which were evaluated with routine preoperative [Figure 1d] and postoperative serial radiographs. The final reduction status of the radial head was divided into three categories: good (complete reduction without osteolytic change), fair (reduction with subluxation or osteolytic change), or poor (radial head dislocation).<sup>27</sup>

### Surgical technique

All operations were performed by the senior author. We performed an open reduction through a Boyd and Speed approach. This approach has the advantage of doing the ulnar osteotomy and open reduction of the radial head using a single incision. For reconstruction of the annular ligament, a 10-cm long central slip of triceps aponeurosis was fashioned (Bell Tawse) of 0.5-cm breadth from proximal to distal. Care is taken not to detach its insertion at the ulna. Now, periosteum was stripped from ulna at the site of osteotomy. A low-energy osteotomy of the ulna was performed at the apex of the deformity, usually about 5 cm from the olecranon by making multiple drill holes, and completes the osteotomy with a bone cutter [Figure 2a]. The radiocapitellar joint was opened, the radial head was exposed, any fibrous tissue hindering the reduction was excised, and we assessed the state of the cartilage of the radial head. Carefully, the aponeurosis was wrapped around the radial neck before reduction of the radial



**Figure 1:** (a) Preoperative cubitus valgus deformity, (b) restricted flexion of the left elbow, (c) hyperextension, (d) preoperative X-ray showing malunited ulna with radial head dislocation



**Figure 2:** (a) Low-energy osteotomy of the ulna by making multiple drill holes, (b) the aponeurosis wrapped around the radial neck, (c) reconstructed annular ligament, (d) osteotomy site angulated and fixed with DCP

head [Figure 2b and c]. Using forearm bone holder, both ulnar fragments were held in angulation and distraction until the radial head reduced without any tension, and the ulna was fixed in the same angulation using a prebent 3.5 system 5-hole dynamic compression plate with a pair of screws holding on either side ensuring contact between the fragments (open wedge osteotomy) [Figure 2d]. The range of angular correction performed was 10°-30°. Additional bone grafting was not performed in any patients. Now, the end of the tricipital aponeurosis was sutured to nondetached end of the aponeurosis using a nonabsorbable suture material. If the distal attachment is torn, then the author recommends to make a drill hole on the ulna and aponeurosis secured to the ulna. Care was taken not to tension the graft around the radial neck. Stability of the radial head was checked, and postoperatively, an above elbow slab was applied to all the patients with the elbow in 90° of flexion, and the forearm was maintained in a neutral position for 5 weeks in all patients. After removal of the slab, we encouraged gentle active movement of the elbow.

### Statistical analysis

The statistical software, namely the Statistical Package for the Social Sciences (version 15.0, SPSS Inc., 233 South Wacker Drive, 11<sup>th</sup> Floor, Chicago, IL 60606-6412, USA), was used for the analysis of the data, and Microsoft Word and Excel was used to generate tables and figures. The *t*-student test was used for mean comparison between the preoperative and postoperative groups.

### Results

Of the 17 children who were studied, all of them had undergone ulnar angular osteotomy and open reduction of the radial head with annular ligament reconstruction. Intraoperatively, articular cartilage of the radial head and capitellum was normal in all 17 cases. At the final followup, the radial head was maintained in a completely reduced position in 16 (94%) children [Figures 3 and 4]. Mean preoperative MEPI score was 76.76 and mean postoperative score was 91.11, which was statistically significant ( $P < 0.001$ )<sup>28</sup> [Table 1 and Figure 5a]. Mean preoperative Kim's score was 76.94 and mean postoperative score was 91.35, which was also statistically significant ( $P < 0.001$ ) [Table 2 and Figure 5b]. We found a significant improvement between preoperative and postoperative elbow

ranges of motion in all patients. At the final followup, the elbow was stable in all 16 children.

The ulnar osteotomy site was united in all 17 children, and none of them required secondary procedures. One girl developed anterior subluxation of the radial head at 1-year followup, she had 10° of restriction of flexion with full range of rotation of the forearm, and mild instability was noted. Ten children had hypertrophic scar, but none of the children complained about the cosmetic problem. We have not identified any complications such as compartment syndrome, infection, posterior interosseous nerve palsy, or AVN radial head.

### Discussion

Missed Monteggia fracture-dislocation in children is common in India due to the traditional method of treatment by bone setters and missing the radial head dislocation by orthopedists. Forced hyperpronation ruptures the capsule and annular ligament, followed by a fracture to the ulna shaft and finally rotation of the radial head, so it lies anterior to the capsule.<sup>5</sup> The interposed capsule and shortening can prevent reduction of the radial head causing it to act as a mechanical block to full flexion demanding open reduction. Mal-union of the fracture ulna in shortening and angulation which further prevent reduction of the radial head until the deformity of the ulna is corrected. If left unreduced, this can result in restricted flexion, unstable cubitus valgus, and ultimately, a painful arthritic elbow due to secondary

**Table 1: Comparison between pre- and postoperative Mayo Elbow Performance Index score**

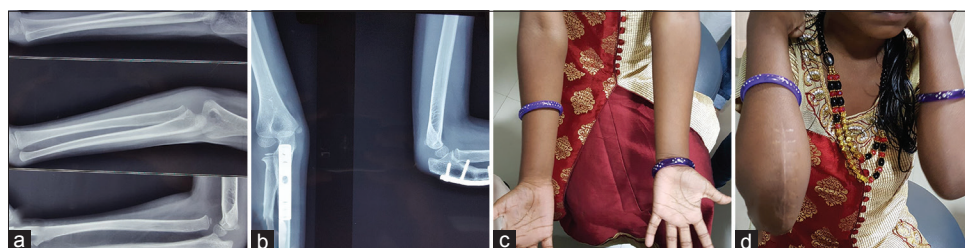
MEPI score	Mean±SD	P
Preoperative	76.76±1.71	<0.001**
Postoperative	91.11±1.11	

Paired *t*-test. \*\* $P < 0.001$ =Highly significant. SD=Standard deviation, MEPI=Mayo Elbow Performance Index

**Table 2: Comparison between pre- and postoperative Kim's score**

Kim's score	Mean±SD	P
Preoperative	76.94±2.24	<0.001**
Postoperative	91.35±1.27	

Paired *t*-test. \*\* $P < 0.001$ =Highly significant. SD=Standard deviation



**Figure 3: (a) Preoperative X-ray showing unreduced Monteggia fracture-dislocation, (b) postoperative X-ray at 1-year followup, (c) at 1-year followup deformity well corrected with full extension, (d) full flexion**

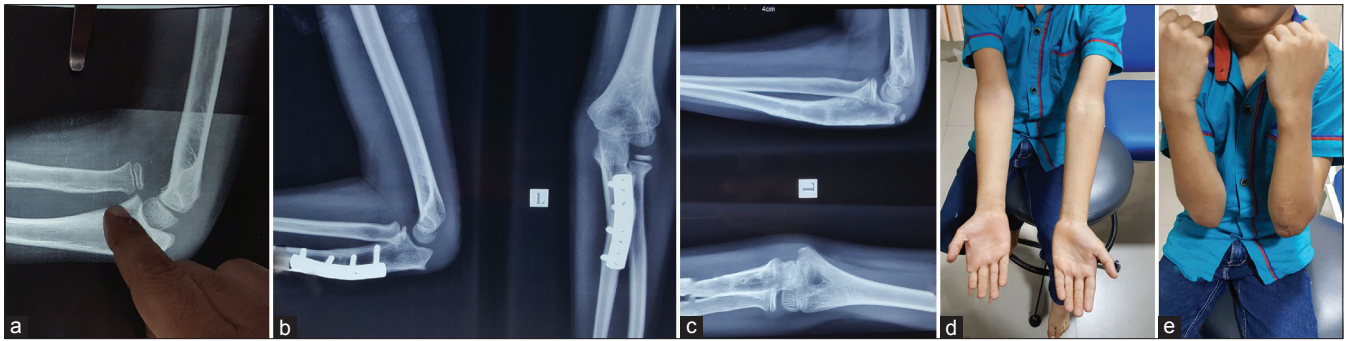


Figure 4: (a) Preoperative X-ray, (b) post-operative X-ray at 1-year followup, (c) 2-year followup, (d and e) range of movement at 2-year followup

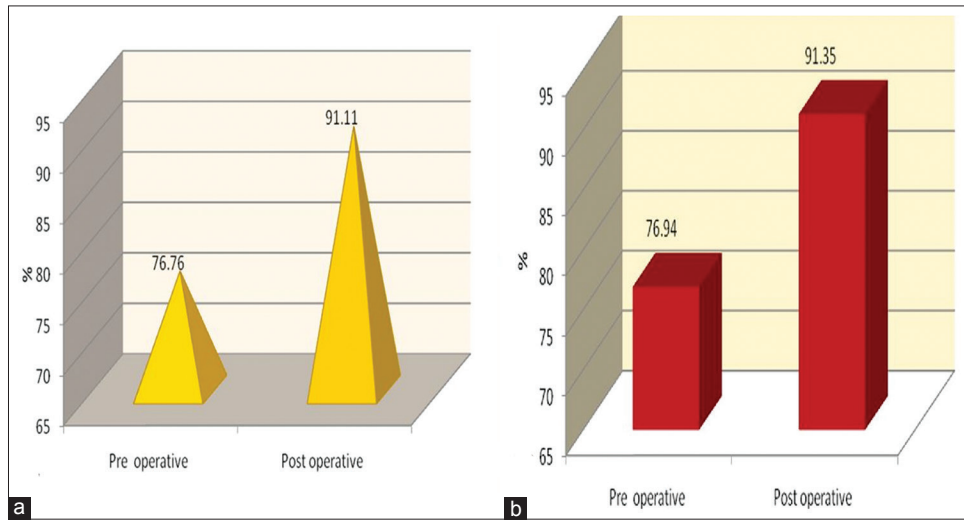


Figure 5: (a) Comparison between preoperative and postoperative Mayo Elbow Performance Index scores, (b) comparison between preoperative and postoperative Kim's score

degenerative changes.<sup>7</sup> Sometimes, cubitus valgus deformity can progress resulting in tardy ulnar nerve palsy.

Bell Tawse originally described his technique for the treatment of malunited anterior Monteggia fractures in 1965.<sup>12</sup> Using a posterolateral approach, the interposed capsular block is exposed and removed from the radiocapitellar joint. The radial head can then be easily reduced without the need to divide the ulna. Bell Tawse described reconstruction of the annular ligament by turning down a slip of the triceps tendon (middle portion of the tendon), leaving it attached to the ulna, and passing it around the neck of the radius from behind forward and securing it through a drill hole in the ulna. Rehabilitation included 6-week immobilization in full extension and supination, followed by gradual mobilization. In their sample of six children, the reduction was easily achieved with good long term followup results. Annular ligament reconstruction seems to be a simple and reproducible technique with overall good success rates reported.<sup>10,13</sup>

Since the originally described technique, several variations have been published in the literature. Lloyd-Roberts and Bucknill described reconstruction of the annular ligament using either a free palmaris longus tendon graft or a lateral

slip of the triceps tendon in their sample of eight patients.<sup>3</sup> Reduction of the radial head was held using a transarticular Kirschner wire. The reason for using a lateral slip of the triceps tendon was because it has a rolled edge and is more substantial than the central slip. It is also anatomically closer to the radial head. They concluded that triceps slip was preferable to palmaris tendon grafting as it avoids unnecessary donor-site morbidity and also that Kirschner wire fixation seems essential to prevent subluxation or recurrent dislocation.

Several authors insist that Annular ligament reconstruction is crucial for the stability of the radial head and are concerned about the lack of stability of the radial head without reconstruction of the annular ligament.<sup>17,25,29</sup> Few studies found that ALR was not mandatory.<sup>5,28-31</sup> Complications, including osteolytic changes, narrowing of the radial neck, growth disturbance, heterotopic ossification, and osteonecrosis of the radial head, have been reported after ALR.<sup>11,19,22,29,32,33</sup>

In our series, we reconstructed annular ligament using a central slip of triceps (Bell Tawse) and securing it on ulna using a drill hole after reduction of the radial head combined with ulnar osteotomy. Care was taken to avoid

excessive tightness and tension of the annular ligament around the radial neck to avoid complication associated with it. During the postoperative period, we immobilized elbow in 90° flexion and midprone position avoiding transcapital pinning. We have achieved a full range of motion except one girl who had a mild anterior subluxation of the radial head with terminal restriction of flexion. Her parents were informed regarding recurrence and warned regarding resurgery; as it was a nondominant side, she is not having any limitations of activities of daily living. We are closely following her.

Hirayama *et al.*<sup>11</sup> used an ulnar osteotomy with overcorrection and elongation aiming to maintain the reduced position of the radial head through the stabilizing action of the interosseous membrane.<sup>11</sup> Ulnar osteotomy has been recommended as a key procedure in the treatment of missed Monteggia fracture and is based on the hypothesis that the primary problem is malunion of the ulna preventing reduction of the radial head.<sup>5,29,30</sup> The osteotomy is performed 5 cm below the olecranon, distracted by up to 1 cm, and fixed with a 15° posterior angulated plate. They described good results in their series of nine patients, and if the radial head is not manually reducible due to excess deformity or chronicity of the injury, then ulnar osteotomy allows reduction to be achieved. This technique has also been supported in the more recent literature,<sup>7,10,16</sup> and some authors advocate that annular ligament reconstruction is only required if the radial head remains unstable intraoperatively.<sup>16,17</sup> There are several complications related to ulnar osteotomy, including delayed union, nonunion, fixation failure, and negative cosmetic problems.<sup>11,22</sup>

There are studies in the literature with recurrence of the dislocation in cases without ulnar osteotomy. In our series, we did ulnar osteotomy in all cases. The osteotomy was done at around 5 cm from the olecranon or at the site of fracture malunion. Once the ulnar osteotomy was performed soft tissue preventing radial head reduction was excised and the osteotomy was fixed using a dynamic compression plate (5-hole 3.5 system) in a angulation where radial head reducible and stable. We have noticed that the radial head was reducible by angulating the ulna (dorsally open wedge) at the osteotomy site in all cases without doing any distraction. Care was taken to close the periosteum whatever possible, and none of the cases required a bone graft for the union. All osteotomies were united at 10-week followup. We had warned all parents regarding the cosmetic issue due to ulnar osteotomy preoperative, so none of patients complained about surgical scar during postoperative period in spite of 10 children developed hypertrophic scar.

At the final followup, we noticed excellent functional outcome in all patients treated with statistically significant improvement in pre- and postoperative MEPI and Kim's score. Results of our study were comparable with articles published in the literature.

The limitations of our study are that it is a retrospective one without randomization, and our sample size was small. However, our number of cases (17 cases) was similar to the size of the cohort of most previous studies. Third, although MEPI has presently been validated only in adults, there is no elbow score for children, and therefore, we used MEPI. To compensate for this limitation, we used an additional functional outcome measure proposed by Kim *et al.*<sup>26</sup>

## Conclusion

Missed Monteggia fracture-dislocation in children is common in India. Chronic unreduced Monteggia fracture-dislocation leads to progressive cubitus valgus deformity in children ultimately resulting in degenerative joint and tardy ulnar nerve palsy; furthermore, there is a constant issue of loss of lateral support and valgus instability. Torn annular ligament and malunited shortened ulna in volar angulation prevent radial head reduction. Open reduction is indicated as early as possible before degenerative changes and adaptive changes make complete disorganization of the biomechanics of the elbow and function. Removal of fibrous tissue hindering reduction of radial head and reversing the ulnar angulation and gaining the length by osteotomy allow radial head reduction without much tension. Annular ligament reconstruction prevents instability of the radial head and recurrence. We recommend ulnar osteotomy, open reduction of the radial head, and annular ligament reconstruction in all children with unreduced Monteggia fracture-dislocation before long term complications sets in.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

## Acknowledgment

Sincere acknowledgement to Dr Shabir Ali, Dr Thomas Varghis, Dr Ajay Kumar, all PG students, Umaiva, Manikandan, Viji sister, Faisal Babu, Sreejith for making substantial contributions to this study.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## References

1. Bhaskar A. Missed Monteggia fracture in children: Is annular ligament reconstruction always required? *Indian J Orthop* 2009;43:389-95.
2. Horii E, Nakamura R, Koh S, Inagaki H, Yajima H, Nakao E.

- Surgical treatment for chronic radial head dislocation. *J Bone Joint Surg Am* 2002;84-A:1183-8.
3. Lloyd-Roberts GC, Bucknill TM. Anterior dislocation of the radial head in children. *The Journal of Bone and Joint Surgery* 1977;59-B(4):402-7.
  4. Di Gennaro GL, Martinelli A, Bettuzzi C, Antonioli D, Rotini R. Outcomes after surgical treatment of missed Monteggia fractures in children. *Musculoskelet Surg* 2015;99 Suppl 1:S75-82.
  5. Bell Tawse AJ. The treatment of malunited anterior Monteggia fractures in children. *J Bone Joint Surg Br* 1965;47:718-23.
  6. De Boeck H. Treatment of chronic isolated radial head dislocation in children. *Clin Orthop Relat Res* 2000;(380):215-9.
  7. Degreef I, De Smet L. Missed radial head dislocations in children associated with ulnar deformation: Treatment by open reduction and ulnar osteotomy. *J Orthop Trauma* 2004;18:375-8.
  8. Devnani AS. Missed Monteggia fracture dislocation in children. *Injury* 1997;28:131-3.
  9. Futami T, Tsukamoto Y, Fujita T. Rotation osteotomy for dislocation of the radial head 6 cases followed for 7 (3-10) years. *Acta Orthop Scand* 1992;63:455-6.
  10. Hasler CC, Von Laer L, Hell AK. Open reduction, ulnar osteotomy and external fixation for chronic anterior dislocation of the head of the radius. *J Bone Joint Surg Br* 2005;87:88-94.
  11. Hirayama T, Takemitsu Y, Yagihara K, Mikita A. Operation for chronic dislocation of the radial head in children. Reduction by osteotomy of the ulna. *J Bone Joint Surg Br* 1987;69:639-42.
  12. Hui JH, Sulaiman AR, Lee HC, Lam KS, Lee EH. Open reduction and annular ligament reconstruction with fascia of the forearm in chronic Monteggia lesions in children. *J Pediatr Orthop* 2005;25:501-6.
  13. Hurst LC, Dubrow EN. Surgical treatment of symptomatic chronic radial head dislocation: A neglected Monteggia fracture. *J Pediatr Orthop* 1983;3:227-30.
  14. Seel MJ, Peterson HA. Management of chronic posttraumatic radial head dislocation in children. *J Pediatr Orthop* 1999;19:306-12.
  15. Wattincourt L, Seguin A, Seringe R. Old Monteggia lesions in children. Apropos of 14 cases. *Chir Main* 1999;18:137-48.
  16. Mehta SD. Flexion osteotomy of ulna for untreated. *Strategies Trauma Limb Reconstr* 2007;2(1):31-4.
  17. Best TN. Management of old unreduced Monteggia fracture dislocations of the elbow in children. *J Pediatr Orthop* 1994;14:193-9.
  18. De Boeck H. Radial neck osteolysis after annular ligament reconstruction. A case report. *Clin Orthop Relat Res* 1997;(342):94-8.
  19. Kalamchi A. Monteggia fracture-dislocation in children. Late treatment in two cases. *J Bone Joint Surg Am* 1986;68:615-9.
  20. Oner FC, Diepstraten AF. Treatment of chronic posttraumatic dislocation of the radial head in children. *J Bone Joint Surg Br* 1993;75:577-81.
  21. Rodgers WB, Waters PM, Hall JE. Chronic monteggia lesions in children. Complications and results of reconstruction. *J Bone Joint Surg Am* 1996;78:1322-9.
  22. Verneret C, Langlais J, Pouliquen JC, Rigault P. Old posttraumatic dislocation of the radial head in children. *Rev Chir Orthop Reparatrice Appar Mot* 1989;75:77-89.
  23. Bado JL. The Monteggia lesion. *Clin Orthop Relat Res* 1967;50:71-86.
  24. Morrey BF. Functional evaluation of the elbow. In: Morrey BF, Sanchez-Sotelo J, editors. *The Elbow and its Disorders*. 2<sup>nd</sup> ed. Philadelphia: Saunders/Elsevier; 1993. p. 86-97.
  25. Cappellino A, Wolfe SW, Marsh JS. Use of a modified bell tawse procedure for chronic acquired dislocation of the radial head. *J Pediatr Orthop* 1998;18:410-4.
  26. Kim HT, Park BG, Suh JT, Yoo CI. Chronic radial head dislocation in children, part 2: Results of open treatment and factors affecting final outcome. *J Pediatr Orthop* 2002;22:591-7.
  27. Nakamura K, Hirachi K, Uchiyama S, Takahara M, Minami A, Imaeda T, *et al.* Long term clinical and radiographic outcomes after open reduction for missed Monteggia fracture-dislocations in children. *J Bone Joint Surg Am* 2009;91:1394-404.
  28. Dahiru T. P – value, a true test of statistical significance? A cautionary note. *Annals of Ibadan postgraduate medicine*. 2008;6:21-6.
  29. Gyr BM, Stevens PM, Smith JT. Chronic Monteggia fractures in children: Outcome after treatment with the bell-tawse procedure. *J Pediatr Orthop B* 2004;13:402-6.
  30. Lloyd-Roberts GC, Bucknill TM. Anterior dislocation of the radial head in children: Aetiology, natural history and management. *J Bone Joint Surg Br* 1977;59-B:402-7.
  31. Lädermann A, Ceroni D, Lefèvre Y, De Rosa V, De Coulon G, Kaelin A. Surgical treatment of missed Monteggia lesions in children. *J Child Orthop* 2007;1:237-42.
  32. Oner FC, Diepstraten AF. Treatment of chronic posttraumatic dislocation of the radial head in children. *J Bone Joint Surg Br* 1993;75:577-81.
  33. Fowles JV, Sliman N, Kassab MT. The Monteggia lesion in children. Fracture of the ulna and dislocation of the radial head. *J Bone Joint Surg Am* 1983;65:1276-82.