



# The results of treatment in pediatric Monteggia equivalent lesions

## Çocuklardaki Monteggia eşdeğer lezyonlarında tedavi sonuçları

Melih GUVEN,<sup>1</sup> Abdullah EREN,<sup>2</sup> Baris KADIOGLU,<sup>2</sup> Umur YAVUZ,<sup>2</sup> Volkan KILINCOGLU,<sup>3</sup> Korhan OZKAN<sup>2</sup>

<sup>1</sup>The Hospital of University of Abant İzzet Baysal, Department of Orthopaedics and Traumatology; <sup>2</sup>Göztepe Training and Research Hospital, 2<sup>nd</sup> Orthopaedics and Traumatology Clinic; <sup>3</sup>Fatih Sultan Mehmet Training and Research Hospital, Orthopaedics and Traumatology Clinic

**Amaç:** Monteggia eşdeğer lezyonlu çocuklarda konservatif ve cerrahi tedavi sonuçları değerlendirildi.

**Çalışma planı:** Çalışmaya, Monteggia eşdeğer kırıklı-çıkığı nedeniyle tedavi edilen 13 çocuk hasta (3 kız, 10 erkek; ort. yaş 8; dağılım 4-13) alındı. Yedi hastada (%53.9) Bado tip 1, altı hastada (%46.2) ise tip 3 eşdeğer lezyon vardı. Tip 3 eşdeğer lezyonlu hastaların ikisinde aynı zamanda humerus lateral kondil kırığı saptandı. Bir hastada (%7.7) radial sinir felci vardı. Açık kırıklı-çıkık nedeniyle acil debridman ve irigasyon uygulanan bir hasta dışında, tüm hastalarda öncelikle kapalı redüksiyon denendi. Sekiz hastada (%61.5) konservatif tedaviyle yeterli redüksiyon sağlandı. Dört hastada (%30.8) redüksiyon sağlanamaması nedeniyle, yaralanmadan sonra ilk 24 saat içinde cerrahi girişim uygulandı. Fonksiyonel değerlendirme Reckling evrelemesine göre yapıldı. Ortalama takip süresi 4.1 yıl (dağılım 2-7 yıl) idi.

**Sonuçlar:** Hiçbir olguda kaynamama gözlenmedi. Konservatif tedavi gören hastaların hiçbirinde radius başında redüksiyon kaybıyla karşılaşılmadı ve dirsek hareketlerinde kısıtlılık gözlenmedi. Bir hastada (%7.7) dirsekte 5° kubitus varus deformitesi, radyografik olarak ise ulnada kırık hattında 20° posteriora açılma saptandı. Konservatif tedavi gören hastaların hepsinde fonksiyonel sonuçlar iyi idi. Cerrahi tedavi uygulanan dört hastada fonksiyonel sonuçlar iyi iken, açık kırıklı-çıkığı olan olguda kötü sonuç alındı. Bir hastada 10° supinasyon kısıtlılığı vardı. Dirsek eklemi hareket genişliğinde fleksiyon ve ekstansiyon kısıtlılığı yoktu. Başvuru anında radial sinir felci olan bu hastada sinir lezyonu ameliyat sonrası üçüncü ayda düzeldi.

**Çıkarımlar:** Çocuklardaki Monteggia eşdeğer lezyonlarda öncelikli tedavi kapalı redüksiyondur. Redüksiyon sağlanamaması durumunda cerrahi tedavi gündeme gelir.

**Anahtar sözcükler:** Çocuk; çıkık/tedavi; kırık tespiti, internal; Monteggia kırığı/tedavi; radius kırığı/tedavi.

**Objectives:** We evaluated the results of conservative and surgical treatment of pediatric Monteggia equivalent lesions.

**Methods:** The study included 13 children (3 females, 10 males; mean age 8 years; range 4 to 13 years) who underwent treatment for Monteggia equivalent lesions. Seven patients (53.9%) had Bado type 1 and six patients (46.2%) had type 3 equivalent lesions. Two patients with type 3 equivalent lesions also had a lateral humeral condyle fracture. On presentation, one patient (7.7%) had radial nerve palsy. Primarily, closed reduction was attempted in all the patients except for one patient who underwent urgent debridement and irrigation for an open fracture-dislocation. Reduction was successful in eight patients (61.5%). Upon failure of closed reduction, four patients (30.8%) underwent surgery within the first 24 hours of injury. Functional assessment was made according to the Reckling's criteria. The mean follow-up period was 4.1 years (range 2 to 7 years).

**Results:** None of the patients had nonunion. Conservative treatment did not result in loss of reduction of the radius head or limitation in the range of motion of the elbow joint. Except for the patient with an open fracture-dislocation leading to a poor functional result, the results were good in all the patients receiving conservative or surgical treatment. One patient (7.7%) treated conservatively developed cubitus varus (5°) and posterior angulation (20°) of the ulnar fracture line. One patient treated surgically had limitation of supination (10°) without limitation of flexion or extension of the elbow joint. Accompanying radial nerve palsy in this patient disappeared in the postoperative third month.

**Conclusion:** Closed reduction is the first choice of treatment in pediatric Monteggia equivalent lesions. Surgical treatment becomes necessary if closed reduction fails.

**Key words:** Child; dislocations/therapy; fracture fixation, internal; Monteggia's fracture/therapy; radius fractures/therapy.

Monteggia fracture-dislocation, is an elbow trauma that constitutes less than 5% of upper extremity fractures, which is described as a radio-humeral dislocation associated with diaphyseal ulnar fracture. While it is seen more commonly in children compared to the adults, it may be seen in every age. This pathology, which has been first described by Monteggia in 1814, was classified into 4 main types and 2 equivalent lesions by Bado<sup>[1]</sup> in 1967 (Table 1). The scope of the description of equivalent lesions by Bado, has been widened by Reckling<sup>[2]</sup> and various fracture variations have been described in many manuscripts.<sup>[3–11]</sup>

If adequate treatment is not applied, similar to Monteggia fracture-dislocation, equivalent lesions may lead to poor clinical and radiographic results. There is no standard treatment protocol for equivalent lesions, for which results are obtained through case reports except several case series. Whereas early closed reduction provides good and excellent results in Monteggia fracture-dislocations, the results in the literature for equivalent lesions are known to be different.<sup>[2, 12, 13]</sup>

In the present study, we evaluated our conservative and surgical treatment approaches and their results on 13 pediatric patients with Bado Type I and Type III Monteggia equivalent lesions.

## Material and methods

Twenty-four patients having at least two years follow-up and who had been hospitalized in our clinic between September 1999 – January 2004 due to Monteggia fracture-dislocation, were evaluated. Among those patients, 13 cases (three female, ten male) in total were included in the present study. The mean age of the patients at the moment of trauma was 7.7 years (range; 4-13 years). Initial and subsequent treatments of all the patients had been carried out in our clinic. While five (38%) patients exhibited right side invol-

vement, eight (62%) patients showed left side involvement. Trauma had occurred due to fall from bicycle in five patients, fall while running again in five patients, and fall from high in three patients.

All the patients were evaluated by antero-posterior and lateral elbow radiographs. Accordingly, equivalent pathologies were categorized in three main groups. Radial neck fracture associated with diaphyseal ulna or olecranon fracture without radial head dislocation was determined in seven (54%) patients; olecranon fracture associated with lateral or anterolateral dislocation of radial head was determined in four (31%) patients; and lateral humeral condylar fracture and lateral dislocation of radial head associated with olecranon fracture was determined in one (8%) while the last combination associated with proximal metaphyseal ulna fracture was determined in another (8%) (Table 2). The patients in the first group were the cases with Type I equivalent lesions described by Bado. The patients in the second and third groups were assessed as having Bado Type 3 Monteggia equivalent lesions. In the present study, there was no patient having Bado Type 2 equivalent lesion associated with elbow posterior dislocation. One of the patients in the last group had Type 3 B open fracture-dislocation according to Gustilo-Anderson.<sup>[14]</sup>

Following the radiographic examination, irrigation-debridement and surgical intervention in the operating room were performed on the patient with Bado Type 3 equivalent lesion including open fracture-dislocation. For the rest of the patients, first, closed reduction was attempted in the emergency room and fixation with long arm splint was applied with the forearm supinated. Before and after the reduction, presence of neurovascular lesion was controlled. One (8%) patient had radial nerve palsy before the reduction. In eight (62%) patients, adequate reduction was

**Table 1.** Bado<sup>[1]</sup> classification in Monteggia fracture-dislocations and equivalent lesions.

Type	Main pathology	Equivalent lesion pathology
1	Anterior radial head dislocation, diaphyseal ulna fracture with anterior angulation	Diaphyseal ulna fracture associated with radial head or neck fracture without radial head dislocation
2	Posterior or posterolateral radial head dislocation, diaphyseal ulna fracture with posterior angulation	Posterior elbow dislocation, radial head or neck fracture and diaphyseal ulna fracture with posterior angulation
3	Lateral or anterolateral radial head dislocation, proximal metaphyseal ulna fracture	
4	Anterior radial head dislocation, proximal 1/3 diaphyseal fracture of radius and ulna	



**Figure 1.** Type 1 equivalent lesion characterized with diaphyseal ulna and radial neck fracture on the left, (a) antero-posterior and (b) lateral elbow radiographs of a seven-year-old male patient taken after he fell from a bicycle. Lateral elbow radiograph (c) taken after closed reduction and the (d) antero-posterior and (e) lateral elbow radiographs taken during the second year of the trauma.

established by conservative treatment and following a mean period of 5.6 weeks (range: 4-6 weeks) after the fracture healing, splint was removed and range of motion exercises were started. In the remaining four (31%) patients who had no open fracture-dislocation, we couldn't achieve closed reduction of the radial head and/or ulna, radial neck or olecranon fractures and therefore surgery was performed (Table 3). All the patients who had been submitted to surgery, were operated within the first day. Postoperatively, long

arm splint was applied to the patients. Following a mean period of 5.2 weeks (range: 4-6 weeks), splint was removed and rehabilitation was started. At the final follow-up, patients were evaluated not just according to the radiographs but also with respect to the functional staging system described by Reckling.<sup>[2]</sup> Accordingly, while less than 10° loss in range of motion was assessed as "good", losses between 10° - 30° were evaluated as "moderate", and losses above 30° were recognized as "poor".



**Figure 2.** Type 3 equivalent lesion characterized with olecranon fracture, lateral radial head dislocation and lateral humeral condylar fracture of a six-year-old female child are seen on the left, (a) antero-posterior and (b) lateral elbow radiographs taken after she fell on the ground. Following open reduction and fixation of lateral humeral condylar fracture with a Kirschner wire (c) antero-posterior and (d) lateral elbow radiographs. Postoperative fourth year elbow radiographs (e) antero-posterior and (f) lateral view.

## Results

Mean follow-up period was 4.1 years (range: 2-7 years). Patients who were submitted to closed reduction and conservative treatment with a long arm splint while the forearm was supinated, were followed-up by series of radiographs. No loss of reduction was observed in the radial head among the patients. One of the patients (8%) who had a conservatively treated Type 1 equivalent lesion including radial neck and diaphyseal ulna fracture without a radial head dislocation, exhibited 5° cubitus varus deformity and a 20° posterior angulation on the ulnar fracture line during the final

controls (Figure 1). This patient who showed a complete union in ulna and radial neck fractures, also had a full range of motion. The other seven patients that have been conservatively treated exhibited no nonunion, malunion, or limited elbow motion. Functional follow-up results were good in all the patients treated conservatively.

Except the patient with open fracture-dislocation, in four (31%) cases which exhibited failure in closed reduction, surgical treatment had been applied due to annular ligament tear-interposition and failed reduction of radial neck, ulna/olecranon and humerus lateral

condylar fracture (Table 3). In a patient who was subjected to surgical treatment against olecranon fracture associated with radial neck fracture without radial head dislocation, recent follow-up session showed a 10° limitation of supination. This patient exhibited no limitation of flexion or extension in elbow range of motion. Moreover, the radial nerve palsy during the presentation of this patient, exhibited a recovery in the neurological examination performed at postoperative third month.

The worst result in our study was obtained from the patient with the Bado Type 3 equivalent lesion including an open fracture-dislocation. In this patient, following debridement and irrigation of Type 3 B open metaphyseal ulna fracture, lateral humeral condylar fracture and lateral dislocation of the radial head, ulnar and lateral condylar fractures had been fixated by one Kirschner wire for each. By the postoperative third month, reconstructive intervention was performed on the skin defect localized in the posterolateral portion of the elbow in the patient who had no deep or superficial infection problem. The functional result of the patient who had 30° extension loss in elbow and a range of motion limited by 90° flexion on the third year follow-up, were poor. Other four patients who had been subjected to surgical treatment, produced good results (Figure 2).

## Discussion

Apart from the Type 1 and Type 2 equivalent lesions described by Bado<sup>[1]</sup>, many Monteggia equivalent pathologies have been reported. These may be summarized as follows: olecranon fracture associated with lateral or anterolateral radial head dislocation,<sup>[3, 4, 15–17]</sup> traumatic bowing of ulna associated with anterior radial head dislocation,<sup>[3]</sup> diaphyseal ulna and olecranon fracture associated with anterior radial head dislocation,<sup>[5]</sup> proximal metaphyseal ulna fracture and lateral condylar humerus fracture associated with lateral radial head dislocation,<sup>[11]</sup> ulnar and radial diaphyseal fracture with posterolateral angulation associated with posterolateral radial head dislocation.<sup>[10]</sup>

Type I equivalent lesions constitute 44% of Monteggia fracture-dislocations in the literature.<sup>[2, 3]</sup> Olney et al.<sup>[3]</sup> described Type 1 equivalent pathologies as third most common lesions following Type 1 and Type 3 among all the Monteggia lesions. In the pre-

sent study, 13 (54%) of children out of 24 pediatric patients with Monteggia fracture-dislocation, showed equivalent fracture-dislocation pathology. Seven (30%) of those were Type 1 equivalent lesions. The pathology in the remaining six (24%) patients were assessed as Type 3 equivalent lesions due to anterolateral and lateral dislocation of the radial head.

In children, similar to Monteggia fracture-dislocation, it is not possible to fully outline the trauma mechanism in equivalent lesions, as well. However, during the initial presentation of the patient; position of the forearm, and the position of the distal portion of fracture and the inclination of the radial head dislocation in radiographs, may provide useful data. Bado<sup>[1]</sup>, proposed the position of the forearm in extension and hyperpronation as factors responsible for the Monteggia lesions and concluded that all the Type 1 equivalent lesions developed while the forearm was at pronation. Givon<sup>[4]</sup> described 16 equivalent lesions among 41 Monteggia fracture-dislocation cases; particularly in cases with diaphyseal ulna and olecranon fracture associated with anterior radial head dislocation, falling with an elbow at flexion position, was held responsible.

Another mechanism held responsible is, known to be traumas having a direct effect on ulnar diaphysis. Greenstick fracture was reported to occur as a result of this.<sup>[4]</sup> Tompkins<sup>[18]</sup> proposed overtraction of biceps muscle as the reason of radial head dislocation due to falling with an open hand. Bado Type 3 fracture-dislocations are seen due to varus stress on elbow during falling with an open hand while elbow is extended.<sup>[19]</sup> The mechanism of lateral humeral condylar fractures and Bado Type 3 fracture-dislocations are similar.<sup>[7]</sup> As a result of this mechanism, lateral dislocation in radiocapitellar joint and subsequent rupture in the lateral condyle may occur. In our study, two of the cases had a lateral humeral condylar fracture associated with a varus stress applied on elbow that occurred a lateral radial head dislocation along hyperpronation and hyperextension.

As long as radial head could be reduced and preserved at this position in Monteggia fracture-dislocations and equivalent lesions of children, conservative treatment is known to be valid.<sup>[1, 18]</sup> Bado<sup>[1]</sup> recommends supination manoeuvre and closed reduction in Monteggia Type I equivalent lesions. Papavasiliou<sup>[20]</sup> applied conservative treatment on 25 of 29 cases with

Type I Monteggia equivalent lesion, and reported full range of motion in 24 of the patients.

If radial head can not be reduced or kept at appropriate position following the reduction, due to the risk of annular ligament interposition, surgical exploration and if required ligament repair, are recommended.<sup>[3, 18, 21]</sup> In the present study, in all the cases except the patient with open fracture-dislocation, first, closed reduction was tried in the emergency room; reduction was accomplished in eight (62%) of those. Splinting was performed at supination position in all of them and no loss of reduction was encountered in radial head and/or ulna, radius and olecranon fractures of all the patients. In four (31%) patients that close reduction failed, surgical intervention was applied within the first 24 hours. In those patients, surgical intervention was decided due to failure of reduction of radial head dislocation, radial neck, olecranon, metaphyseal ulna and lateral humeral condylar fracture; annular ligament interposition and annular ligament tear.

Olney et al.<sup>[3]</sup> performed surgical treatment on 10 (71%) of 14 patients with Type 1 equivalent lesion. However, no difference could be found with regard to long-term results between conservative therapy and surgical treatment groups. Olney, proposes that surgery should be planned according to the stability of the ulnar fracture in cases with Type 1 equivalent lesions including diaphyseal ulna and radial neck fractures. If the fracture is stable, fracture localized to the proximal portion of the radius can be treated conservatively in a way similar to the treatment of isolated radial neck fracture. If it proves to be unstable, internal fixation should be applied before open or closed reduction of the proximal radial fracture.<sup>[3]</sup> In our case series, surgery was performed in two (29%) of seven patients with equivalent lesions due to failure to reduce a radial neck fracture and comminuted olecranon fracture. In our two cases with Greenstick type diaphyseal ulna fracture accompanied by radial neck fracture, closed reduction sufficed. In three (50%) of six cases with Type 3 equivalent lesion, surgical intervention was applied.

While complications such as nonunion and limited range of motion could be encountered during treatment of Monteggia equivalent lesions in adults, the results in children are reported to be satisfactory.<sup>[4, 22]</sup> Many staging system are used for assessment of the functional results.<sup>[2, 16, 23]</sup> All of those are based

on the elbow range of motion. In the present study, functional assessment was carried out according to the system of Reckling.<sup>[2]</sup> The functional results were good in all the patients treated conservatively. Four patients treated surgically had good functional results while the case with open fracture-dislocation gave a bad result.

The most common nerve lesion in Monteggia fracture-dislocations and equivalent lesions, belongs to radial posterior interosseous nerve and this condition is generally of self-limited character.<sup>[4, 16]</sup> Moreover, ulnar varus deformity has been a focus of interest as the most common deformity seen during long-term follow-ups.<sup>[3]</sup> Ramsey<sup>[13]</sup> concluded that this deformity might diminish by time. One (8%) of the patients in our case series had a radial nerve neuropraxia which had been determined prior to closed reduction and recovered during the third month. A case with Type 1 equivalent lesion treated conservatively, exhibited 5° cubitus varus deformity in the elbow joint and 20° posterior angulation in ulna. There was no limitation in range of motion of this patient.

In children, Monteggia fracture-dislocations may occur in various forms and as uncommon fracture variations. In order to avoid the complications by establishing an early diagnosis and treatment, a good understanding of the fracture patterns and accurate diagnose of the lesions are required. Currently, as for the Monteggia fracture-dislocations, closed reduction is the first choice of treatment for equivalent lesions. Following conservative treatment, reduction of radial head should be controlled by a series of radiographs. If adequate reduction can not be achieved after closed reduction of radial head dislocation or associated fractures, surgery should be considered. In the present study, initially conservative treatment was preferred. Requirement of surgery has been associated with failure of reduction in radial head dislocation or fracture, annular ligament interposition or tear, displaced olecranon or metaphyseal ulnar fracture and lateral humeral condylar fracture especially in patients with Type 3 equivalent lesions.

## References

1. Bado JL. The Monteggia lesion. *Clin Orthop Relat Res* 1967;(50):71-86.
2. Reckling FW. Unstable fracture-dislocations of the forearm (Monteggia and Galeazzi lesions). *J Bone Joint Surg [Am]* 1982;64:857-63.

3. Olney BW, Menelaus MB. Monteggia and equivalent lesions in childhood. *J Pediatr Orthop* 1989;9:219-23.
4. Givon U, Pritsch M, Levy O, Yosepovich A, Amit Y, Horoszowski H. Monteggia and equivalent lesions. A study of 41 cases. *Clin Orthop Relat Res* 1997;(337):208-15.
5. Ruchelsman DE, Klugman JA, Madan SS, Chorney GS. Anterior dislocation of the radial head with fractures of the olecranon and radial neck in a young child: a Monteggia equivalent fracture-dislocation variant. *J Orthop Trauma* 2005;19:428-31.
6. Eglseder WA, Zadnik M. Monteggia fractures and variants: review of distribution and nine irreducible radial head dislocations. *South Med J* 2006;99:723-7.
7. Ravessoud FA. Lateral condylar fracture and ipsilateral ulnar shaft fracture: Monteggia equivalent lesions? *J Pediatr Orthop* 1985;5:364-6.
8. Faundez AA, Ceroni D, Kaelin A. An unusual Monteggia type-I equivalent fracture in a child. *J Bone Joint Surg [Br]* 2003;85:584-6.
9. Hung SC, Huang CK, Chiang CC, Chen TH, Chen WM, Lo WH. Monteggia type I equivalent lesion: diaphyseal ulna and radius fractures with a posterior elbow dislocation in an adult. *Arch Orthop Trauma Surg* 2003;123:311-3.
10. Bhandari N, Jindal P. Monteggia lesion in a child: variant of a Bado type-IV lesion. A case report. *J Bone Joint Surg [Am]* 1996;78:1252-5.
11. Mullick S. The lateral Monteggia fracture. *J Bone Joint Surg [Am]* 1977;59:543-5.
12. Letts M, Loch R, Wiens J. Monteggia fracture-dislocations in children. *J Bone Joint Surg [Br]* 1985;67:724-7.
13. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg [Am]* 1976;58:453-8.
14. Wiley JJ, Galey JP. Monteggia injuries in children. *J Bone Joint Surg [Br]* 1985;67:728-31.
15. Boyd HB, Boals JC. The Monteggia lesion. A review of 159 cases. *Clin Orthop Relat Res* 1969;(66):94-100.
16. Caterini R, Farsetti P, D'Arrigo C, Ippolito E. Fractures of the olecranon in children. Long-term follow-up of 39 cases. *J Pediatr Orthop B* 2002;11:320-8.
17. Tompkins DG. The anterior Monteggia fracture: observations on etiology and treatment. *J Bone Joint Surg [Am]* 1971;53:1109-14.
18. Papavasiliou VA, Nenopoulos SP. Monteggia-type elbow fractures in childhood. *Clin Orthop Relat Res* 1988;(233):230-3.
19. Biyani A, Olscamp AJ, Ebraheim NA. Complications in the management of complex Monteggia-equivalent fractures in adults. *Am J Orthop* 2000;29:115-8.
20. Bryan RS. Monteggia fracture of the forearm. *J Trauma* 1971;11:992-8.