Neglected monteggia fracture-dislocations in children

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Abstract

Aim: Presently, there are few large-scale studies and no clear consensus on the type of osteotomy or ligamentoplasty to be performed in neglected Monteggia fractures-dislocations cases. The goal of this study was to report the results from neglected Monteggia fractures and dislocations. Material and Method: Thirteen children and adolescents with neglected Monteggia fractures and dislocations were treated between 2009 and 2012. There were 11 males and two females with a mean age of 8.5 (range 3-15) years. Based on the BADO classification, 11 patients had type 1, one patient had type 3, and one patient had type 4 injuries. Time delay from symptom onset to fracture was 8.84 (3-24) months. The data were analyzed using R version 3.1.1 and multiple statistical analyses were conducted. Results: A postoperative Mayo Elbow Performance Index (MEPI) at the time of follow-up was recorded. Nine patients received an excellent grade, while three had good and one had a fair result with no poor results recorded. Radiographically, there were nine good, four fair, and no poor score results. The length of hospitalization was a mean of 3 days. The mean duration of follow-up was 2.9 (range 1.5-4.5) years from the initial presentation, and only one patient developed subluxation for which no additional intervention was performed. Discussion: This case series demonstrates that early diagnosis increases the success rate in patients younger than 10 years and less than a 1-year interval between the trauma and diagnosis. Unless it is kept for a prolonged time, a condyloradial pin can be applied in necessary cases. Level of evidence: IV

Keywords

Monteggia Fracture; Radius Head Dislocation; Pediatric Fractures
Introduction
Monteggia fractures are defined as fractures of the proximal third of the ulna with anterior dislocation of the head radius [1]. They rarely occur and constitute only 2.0% of all fractures. Unlike adults, treatment with conservative methods is often enough in acute injuries during childhood. However, diagnosis can be delayed in some patients. After a couple of months or longer, these patients can return with complaints of pain, weakness, limited range of motion, disturbed appearance in the elbow, and nerve injury, which includes sensory or motor loss caused by a tardy ulnar nerve palsy or a posterior interosseus nerve palsy [2,3,4].

Treatment processes can become quite complicated in neglected cases or when the diagnosis is delayed. When the interval between time of trauma and treatment exceeds three weeks, conservative treatment does not provide successful outcomes. Surgical treatment is inevitable in these cases. Various procedures have been described for surgical treatment. The most common of these approaches is open reduction of the head of the radius, open wedge osteotomy of the ulna, and/or ligamentoplasty [5]. There is no general consensus on which type of osteotomy or ligamentoplasty is to be performed. There are few studies on the outcomes of neglected Monteggia fractures. In our study, we present medium and long-term treatment outcomes for neglect cases with Monteggia fracture-dislocation.

Material and Method
In this study, we retrospectively reviewed 13 Monteggia fracture-dislocation neglected cases that were treated in our clinic between the years 2009 and 2012. Before their admittance to the hospital, bonesetters manipulated all of these cases using traditional methods. Eleven of the patients were male and 2 were female, while the mean age of the patients was 8.5 years (range: 2-15). The mean follow-up time was 2.9 years (range: 1.5-4.5 years). Five patients had a fracture-dislocation in their right extremity, and 8 patients were affected in their left extremity. The trauma occurred due to falls from height in 4 patients, simple falls in 4 patients, falls from donkeys in 3 patients, and birth trauma in 2 patients. The average duration between time of trauma and diagnosis was 8.84 months (range: 3-24).

Diagnosis was made with antero-posterior (AP) and lateral X-rays of the elbow. Evaluation was made according to the BADO classification. According to the BADO classification, there was anterior dislocation in type 1 and 4 injuries (accompanied by radial diaphysis fracture), posterior dislocation in type 2 injuries, and anterolateral dislocation in type 4 injuries (Table 1). All were in relation to the head of the radius. Based on this classification, 11 of our patients had a type 1 injury, one patient had a type 3 injury, and one patient had a type 4 injury (Table 1). There was no patient with a type 2 injury. Two patients had plastic deformation type fractures, 9 patients had a fracture in proximal ulnar diaphysis, one patient had fractures at the distal third of the radius and ulnar diaphysis, and one patient had fracture at the ulnar metaphysis.

Surgical intervention was performed under general anesthesia. The patients were placed in the supine position with the elbows semi-flexed and the forearms pronated on a conventional surgical table. Tourniquet use was optional, and posterolateral approach was preferred for manipulations on the radial head [6].

Table 1. Details of preoperative and postoperative findings.

<table>
<thead>
<tr>
<th>Patients</th>
<th>Age/ gender</th>
<th>Bado type</th>
<th>Fracture type</th>
<th>Interval (month)</th>
<th>Ligamentoplasty</th>
<th>C.R. Pin</th>
<th>Ulna osteos.</th>
<th>Mean FU(year)</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>15/M</td>
<td>Type 1</td>
<td>Prox.1/3 ulna diaphysis fxr</td>
<td>5</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>4.5</td>
<td>Stiffness</td>
</tr>
<tr>
<td>Case 2</td>
<td>7/M</td>
<td>Type 1</td>
<td>Prox. 1/3 ulna diaphysis fxr</td>
<td>4</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>2.2</td>
<td>Stiffness</td>
</tr>
<tr>
<td>Case 3</td>
<td>10/M</td>
<td>Type 1</td>
<td>Prox.1/3 ulna diaphysis fxr</td>
<td>4</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>3.8</td>
<td>Delayed union</td>
</tr>
<tr>
<td>Case 4</td>
<td>15/M</td>
<td>Type 1</td>
<td>Prox. 1/3 ulna diaphysis fxr</td>
<td>5</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>2.3</td>
<td>Stiffness</td>
</tr>
<tr>
<td>Case 5</td>
<td>10/M</td>
<td>Type 1</td>
<td>Prox. 1/3 ulna diaphysis fxr</td>
<td>4</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>3.7</td>
<td>Stiffness</td>
</tr>
<tr>
<td>Case 6</td>
<td>8/M</td>
<td>Type 1</td>
<td>Prox. 1/3 ulna diaphysis fxr</td>
<td>24</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>3.4</td>
<td>No</td>
</tr>
<tr>
<td>Case 7</td>
<td>8/F</td>
<td>Type 1</td>
<td>Prox. 1/3 ulna diaphysis fxr</td>
<td>4</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>3.1</td>
<td>No</td>
</tr>
<tr>
<td>Case 8</td>
<td>2/F</td>
<td>Type 1</td>
<td>Plastic deformation</td>
<td>24</td>
<td>+</td>
<td>K wire.</td>
<td>Osteost.</td>
<td>1.5</td>
<td>No</td>
</tr>
<tr>
<td>Case 9</td>
<td>8/M</td>
<td>Type 4</td>
<td>Distal -1/3 ulna ‒radius diaphysis fxr.</td>
<td>6</td>
<td>+</td>
<td>K wire.</td>
<td>Osteost.</td>
<td>2.2</td>
<td>No</td>
</tr>
<tr>
<td>Case 10</td>
<td>10/M</td>
<td>Type 3</td>
<td>Prox. 1/3 ulna diaphysis fxr</td>
<td>5</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>2.1</td>
<td>No</td>
</tr>
<tr>
<td>Case 11</td>
<td>2/M</td>
<td>Type 1</td>
<td>Plastic Deformasion on ulna diaphysis</td>
<td>24</td>
<td>+</td>
<td>K wire.</td>
<td>Osteost.</td>
<td>2.8</td>
<td>No</td>
</tr>
<tr>
<td>Case 12</td>
<td>10/M</td>
<td>Type 1</td>
<td>Prox. 1/3 ulna diaphysis fxr</td>
<td>6</td>
<td>+</td>
<td>Plate.</td>
<td>Osteost.</td>
<td>2.9</td>
<td>No</td>
</tr>
<tr>
<td>Case 13</td>
<td>6/M</td>
<td>Type 1</td>
<td>Ulna proximal metaphis fxr</td>
<td>7</td>
<td>+</td>
<td>K wire.</td>
<td>Osteost.</td>
<td>3.2</td>
<td>No</td>
</tr>
</tbody>
</table>

FU: Follow up, C.R Pin: Condyloradial pin
The incision was started over the lateral epicondyle of the humerus, continued on the radiocapitellar joint and proximal ulnar metaphysis, and extended until the mid-diaphysis passed from the posterior of the ulna. Additionally, in one case with a type 4 injury, the dorsolateral incision was made over the distal ulna. Intra-articular fibrotic structures were removed. First, an appropriate length was achieved with the ulnar osteotomy (Figure 1-a,b,c,d). The angulation distraction osteotomy was performed in 12 patients, and proximal metaphyseal posterior bending osteotomy was performed in one patient. Later, the head of the radius was reduced and annular ligament repair was performed in 5 patients. Ligamentoplasty with tricipital ligament was performed in 8 patients for whom annular ligament repair was not applicable (Table 1). Following ligamentoplasty, no pin was placed in patients who had a stable radial head, whereas a condyloradial pin was placed in 6 patients with an unstable radial head. As we did not have any patients with distraction length exceeding 10 mm, we did not use a bone graft. The ulna was fixated with plaque-screws in 9 patients and with intramedullary K wire in 4 patients. No cases required radial osteotomy and the mean operation time was 80 minutes (range: 70-90). Postoperatively, long arm splints were applied to all patients with the forearms in the neutral position. The splints were removed after 3rd-4th weeks, and they were replaced with splints that allowed partial motion and were kept until the 6th week. Approximately 3 weeks after surgery, controlled movements were initiated in order to achieve a full range of motion in the joint. A full load was applied six weeks later, and the patients were examined monthly during the first 6 months followed by visits once every 6 months. Functional evaluation was based on parameters including pain, range of motion, stability, daily life comfort, and Mayo Elbow Performance Index (MEPI) [7]. Radiological evaluation was made using AP and lateral radiograms of the elbow. In radiograms, the head of the radius, osteoarthritic changes, radial frontal neck angle, and radial head hypertrophy were evaluated according to criteria described by Kim et al. [8]. Radiological findings were noted as good (complete reduction of elbow without osteoarthritis), moderate (osteoarthrosis of elbow together with resistant subluxation), or poor (complete dislocation of the head of radius).

Data were analyzed using R version 3.1.1 and multiple statistical analyses were conducted. A two-way multivariate analysis of variance (MANOVA) between patients with the independent variables of 2 (treatment group) X 2 (age group) was used to analyze the treatment, age, and interaction (treatment X age) effects on the ROM and MEPI scales. The dependent variables introduced into the analyses were the scores of the ROM (flexion, extension, pronation, supination) and MEPI (pain, motion, daily life) scales. For verifying significant effects of independent variables (treatment and age) on each of the ROM and MEPI scales, we conducted the univariate two-way ANOVA procedure. Following the multivariate and univariate analysis, we also tested to see whether there were significant directional mean differences between groups of patients, older or younger than age 10.

Results

Radiological signs of bone union began to appear at 6th-7th weeks on average. Radiographs at the latest review showed that the radial head was successfully reduced in all cases. According to two-way MANOVA results given in table 2, we concluded that the treatment and age factors affected the ROM and MEPI scales within an additive manner (i.e., without interaction). The univariate two-way MANOVA procedure revealed significant effects of treatment (i.e. Pre-Op and Post-Op) and age (i.e. less or more than 10 years old) on each of the ROM and MEPI scales, at any reasonable significance level except for daily life that is not affected by treatment (Table 3 and 4). For both of the ROM and the MEPI scales, patients that were less than ten years old have greater mean scores. We conducted pairwise t-test for each scale to test the null hypothesis and the mean difference between paired scores. No patients had an interval time longer than 1 year when comparing patients older than 10 years old to patients younger than 10 years old. There was no significant difference with regards to MEPI and joint range of motion. There were 3 patients whose interval time was longer than 1 year, and all of them were younger than 10 years old. Three patients younger than 10 years old had a 24-month interval time. All other patients had interval times shorter than 12 months (Table 1).
Radiologically, one patient had an osteochondral lesion, while none of our patients had dysmorphism at the radial head. K wires were removed after 2-2.5 months on average, whereas plaque-screws were removed on average at the 6th month. Two of our patients developed superficial infection at the bottom of screw that was responsive to treatment. A total of 5 patients developed complications such as subluxation (n:1), osteoarthritis (n:1), delayed bone union (n:1), and elbow rigidity (n:2). One of these patients was younger than 10 years old, and the other 4 patients were older than 10 years old. Three patients developed calcification around the head of the radius (ectopic calcification), postoperatively. None of our patients had a lack of union accompanied with implant failure. None of our patients developed myositis ossificans, complete dislocation, neurologic vascular complication, or compartment syndrome. None of our patients required intervention aimed at complications other than the implant removal.

Discussion
As with other orthopaedic fractures, in Monteggia fractures the impact of the use of traditional bonesetters on neglect was studied. Sargin et al. [12], have assessed the preference for the use of bonesetters and other influencing factors in Turkish society. The study emphasized that the use of bonesetters is prevalent in Turkey and that increasing the informative health education programs and more state supervision may be effective solutions.

The natural history of the disease is not benign if left untreated. It can lead to progressive valgus deformity, instability, and decreased range of motion. Surgery is advised to achieve anatomic reduction of the radial head, to prevent progressive valgus instability, and to improve cosmetic appearance and range of motion. Currently, many authors recommend surgical intervention when: 1) diagnosis is made early; 2) there is limited range of motion, weakness, progressing deformity, normal concave radial head, or convex capitellum, and 3) the family and the patient are aware of the benefits of reconstruction procedure. However, there are few large-scale studies related to surgical outcomes of neglected Monteggia fractures [3, 9, 10, 11, 13]. For that reason, there is a lack of consensus on the most appropriate age to perform surgery; ligamentoplasty; interval between the time of trauma and surgery; and the type of osteotomy in delayed cases with Monteggia fractures. According to Nakamura et al. [14], favorable outcomes can be expected in the long term in delayed cases, when the patient presents before 12 years of age and within three years after the trauma. We also observed that outcomes were worse with increasing age and interval. In chronic cases with Monteggia fractures, we can achieve less painful and more functional elbows with appropriate surgery and early rehabilitation. This is only if the interval is shorter than 12 months and patients are younger than 10 years old. While we observed four complications among patients older than 10 years old, we only saw one complication among patients younger than 10 years old. We think the reason for fewer complications is related to the fact that we had a high number of patients younger than 10 years old, with interval less than one year.
Ligament repair is a controversial issue and some authors stated it is not necessary [15]. If the head of the radius does not fit into place after angulation distraction osteotomy, then there should either be a pseudocapsule preventing reduction of the radial head or the remnant annular ligament should be stuck between the joint. For that reason, when the head of the radius does not fit into place with closed reduction, some authors performed arthrography, and made an excision under arthrographic guidance. According to the authors, additional surgical procedures would increase rigidity, AVN, heterotopic ossification, and radioulnar synostosis [16]. In one study, the authors detected annular ligaments that were stuck in the joint space and repaired five of them [17]. In one study, they repaired overturned annular ligaments in two patients [18]. In another study, the authors approved late repair of the annular ligament for better functioning and less long-term pain [19]. According to the generally accepted view, the major problem is the poor bone union in the ulna that prevents reduction of the head of the radius [20]. Nishio et al. [21] and Bouyala et al. [22] all reported on the use of ulnar osteotomy for the treatment of radial head dislocation after a missed Monteggia fracture. The concept of ulnar osteotomy in those reports was that the osteotomy tightened the interosseous membrane sufficiently to keep the radial head in a correct anatomical position. Nevertheless, some authors preferred elongation with the use of an external fixator and correction of the angulation and did not perform open reduction in any patient. They reported their results as satisfactory [23]. Most authors gave advice on ligament repair together with osteotomy. Several methods have been proposed on the surgical procedures for reconstruction of the anular ligament such as using a free palmaris longus tendon [24], pedicled forearm fascia [25], pedicled fascia of the triceps [26, 8], and the remnant of the anular ligament [17]. Some authors approved of the late repair of the annular ligament for better functioning and less pain in the long term [19]. Delpont et al. [15] performed ligamentoplasty in one group of patients but did not perform it in the other group. They reported that the group that had ligament repair had better outcomes compared to those without repair. Nakamura et al. [14] initially used forearm fascia and then remnant annular ligament beginning from 1997, by augmenting them with free tendon grafts. They reported their outcomes were better. We performed ligament repair in all our patients and saw a great benefit. In our opinion, annular ligament has great importance for maintaining the radial head in place, and it is statically and dynamically the main stabilizer. We think it is a more appropriate biological option to provide elbow restoration. The decision for ligament reconstruction was made after osteotomy. Since we could not achieve complete reduction of the radial head after osteotomy in any of our patients, we performed ligament repair in all of our patients. We did not detect prevention of rotational movements of the radial head due to ligament repair. Therefore, we approved of the ligament repair in terms of elbow biomechanics. Application of pins is rarely required if the performed ligamentoplasty and osteotomy provides appropriate tension. In our opinion, if the radial head is deformed and there are limited options, then a temporary condyloradial pin may be applied for 2-3 weeks. In our study, we did not detect any issues due to application of the condyloradial pin, whereas according to Delpont et al. [15] it is contraindicated. A sturdy ulnar fixation is necessary in order to maintain the stability of the radial head. There is no consensus on the fixation methods for ulnar osteotomy. Since 11 of our patients had their fractures at the diaphysis region, angulation distraction osteotomy was performed in these patients. Metaphyseal osteotomy was performed in the remaining patients. All diaphysis fractures were in short oblique, incomplete, and plastic deformation type. We had quite successful results with simple transverse osteotomy together with intramedullary pin application in four of our patients below 10 years of age. For children aged 10 years or older (regardless of the type of fracture) rigid osteosynthesis was performed using a plaque screw. Despite performing a 5-mm distraction to achieve adequate length in some of our patients, none of our patients required autograft, and as a result, bone union was achieved in all of our patients.

Conclusions
Early diagnosis, less than 1-year interval between the time of trauma and diagnosis, and patient age younger than 10 years are considered to be factors with favorable effects on treatment outcome. Ligament reconstruction, together with ulnar restoration, is a more biological option. This option restores the elbow biomechanics and increases performance. In addition, the use of condyloradial pins increase radial head stability in appropriate cases.

Scientific Responsibility Statement
The authors declare that they are responsible for the article’s scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement
All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest
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