

Monteggia Fractures in Childhood – Diagnosis and Management in Acute and Chronic Cases

Current Concepts and Review of the Literature

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Abstract

Monteggia fractures are rare injuries. Early recognition is crucial in order to achieve good functional results. In the presented review paper it is pointed out that any fracture or angulation of the ulna should thoroughly be checked for any incomplete or complete dislocation of the radial head. Adequate clinical examination and radiologic evaluation are mandatory. The aim of treatment must be repositioning and retention of the radial head and restoration of the ulnar alignment. During the last years, surgical treatment has become more important for achieving good functional results and for avoiding secondary corrective surgery. For the majority of acute Monteggia lesions, immediate repositioning maneuvers with surgical stabilization of the ulna (elastic nailing techniques) under general anesthesia are indicated. Cast immobilization is of short duration; physical therapy is normally not necessary. Treatment of missed Monteggia lesions or chronic radial head dislocations is more difficult. Nevertheless, newer surgical techniques for secondary operative correction of ulnar malalignment are promising.

Key Words

Monteggia lesion • Ulna fracture • Radial head dislocation • Acute • Chronic • Diagnosis • Treatment

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General

History

The combination of a proximal ulna fracture with a radial head dislocation has first been described by the Italian surgeon Giovanni Battista Monteggia (1762–1815) in 1814 [23]. In the mid-1800s Cooper stated that any fracture of the ulna may be accompanied by radial head dislocation [6]. Some decades ago, several other authors theorized on the fracture patterns, mechanism of injury, and treatment options [10, 27, 32, 33, 36, 44]. One useful description of the fracture patterns in Monteggia lesions was introduced by José Luis Bado in 1958 [1]. In the last 2 decades, the knowledge about Monteggia lesions in children has significantly improved [42], and the mechanism of injury as well as fracture patterns have increasingly better been understood. It is the aim of this article to provide the state of the art in diagnostics and treatment of Monteggia fractures in childhood.

Incidence

The Monteggia lesion is an uncommon injury [21]. Bado [2] described an incidence of 1.7% in a cohort of 3,200 patients with forearm fractures. It took Olney & Meneaus [25] 25 years to collect 105 pediatric patients with acute Monteggia lesions, providing evidence of the relative rareness of this fracture pattern. Letts [21] reported on a series of 33 children who were treated over a 5-year-period in the Winnipeg Children's Hospital, Canada. Patients' age ranges between 2 months and adulthood with a peak incidence between 7 and 10 years.

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Mechanism of Injury

The main cause of radial head dislocation with associated ulnar shaft fracture is a hyperextension mechanism of the elbow joint [9, 36]. A hyperpronation mechanism has also been described, but occurs only in a small population of patients [10]. Generally, a direct and an indirect mechanism can be distinguished. The theory by Odgen [24] best describes the indirect mechanism and may play a more important role in the etiology of this lesion than commonly accepted. He stated, that the child usually falls on the extended and pronated arm, causing fixation of the hand in the moment of impact. The weight of the falling body produces a torsional component at the elbow joint, causing external rotation of humerus and ulna. While the ulna is deformed, the radius is forced into extreme pronation. If the pronation force is big enough, radial head dislocation will result. To provoke radial head dislocation, neither radioulnar contact during pronation with deformation nor total disruption of the annular ligament is mandatory. If the force is big enough to cause plastic deformation of the ulna, a fracture will occur. Another mechanism, caused by a direct blow from dorsal to the proximal ulnar shaft, can also result in an ulnar shaft fracture in association with an anterior dislocation of the radial head. However, in children this mechanism is rather uncommon [21].

Fracture Patterns

In Monteggia lesions, the location of the ulnar shaft fracture varies. In about 60% of cases, the fracture is located between middle and proximal third of the ulnar shaft. In 15% of patients, the fracture is located in the middle third, and in the remaining others are equally distributed to either the olecranon region or the distal ulnar shaft [24]. The fracture of the ulna can appear as complete or greenstick fracture, or just as slight bowing. An apparent mildness of the character of the ulnar fracture, however, might diagnostically be misleading and the severity of the whole injury pattern (including the radiocapitellar joint incongruity) might be underestimated. Consequently, delayed recognition or incomplete reduction is common. Fractures of both, the radius and the ulna are also seen in combination with a dislocation or fracture-dislocation of the radial head. However, their incidence is rather low in children.

Accompanying Fractures

Due to the mechanism of injury with the child most often falling on the wrist, accompanying injuries can be

encountered at the distal radius and/or ulna [35]. Therefore, accurate diagnostic assessment of the hand, the wrist and the whole forearm is substantial to avoid neglect of secondary injuries. Fracture-dislocations of the radial head in combination with proximal radius fractures have also been described in the literature [39]. In comparison to adults, fractures extending through the epiphysis of the radial head are not encountered in children.

Diagnosis

Assessment of the neurovascular status is mandatory. This might be difficult to obtain in children, since physical examination of the painful arm is often not tolerated. However, indirect signs such as peripheral perfusion, skin color, usage of the hand and function of the fingers are helpful for detection of neurovascular deficits. In any case of forearm trauma, the examiner should have in mind that injuries appearing as ulnar or forearm fracture could also be a Monteggia lesion. Especially in children, a greenstick fracture of the ulna often causes surgeons to overlook a Monteggia lesion [24, 28]. Clinically, the child with a Monteggia fracture keeps the arm in a pronated and flexed position to reduce the pain. This feature is comparable to the so-called nurse-made elbow (pronation douloureuse, Chassaignac) in which an incomplete dislocation of the radial head is provoked by a sudden pull on the outstretched arm. In contrast to the Monteggia lesion the patient does not experience ulnar shaft pain. Since the displaced radial head can significantly alter extension/flexion of the elbow, standard radiographs are often difficult to obtain. The obvious ulnar fracture may be the predominant radiologic and clinical feature that focuses attention on the ulnar lesion. Nevertheless, radiologic diagnostics must include anteroposterior (AP) X-rays of the forearm (including elbow *and* wrist) and a lateral view of the elbow. Normally, the longitudinal axis of the radial shaft in lateral view points toward the center of ossification of the humeral capitellum regardless of the degree of elbow flexion (Figure 1). If the line misses the humeral capitellum, the radial head is generally sub- or dislocated. It is important to use the lateral radiograph for control of the radial head localization. In AP radiographs, anterior or posterior radial head dislocations, which account for the majority of the cases, might be overlooked. Furthermore, in the AP radiograph, the radial shaft axis might deviate laterally from the capitellum, if the forearm is pronated. In the lateral

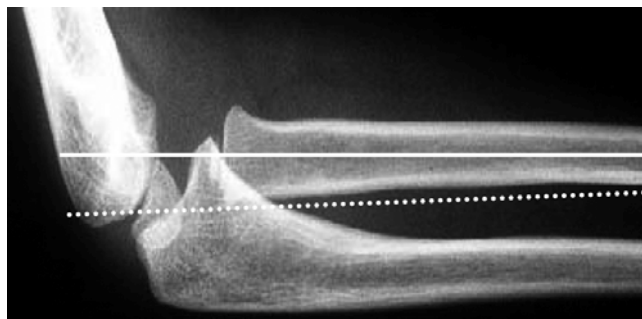


Figure 1. Using the lateral radiograph, a line drawn along the radial shaft axis normally points toward the center of the capitellum. This rule is independent of the degree of elbow flexion. As shown, deviation of this line from the capitellar center (pointed line) indicates radial head dislocation.

view, a line drawn at the posterior margin of the ulna is helpful for detection of ulnar bowing and radial head dislocation (Figure 2). If the line is bent toward the radius, an anterior radial head dislocation is likely. Very often, a forearm fracture is initially expected. Consequently, X-rays are centered on the middle of the forearm. Additional X-rays, centered on the elbow joint, are then recommendable in order not to miss subtle accompanying lesions.

Ultrasound has become a more and more valuable tool for diagnosing radial head dislocation. It has been shown that ultrasonography can successfully be used for localizing the unossified epiphysis and for diagnosing dislocations, physeal separations and fractures. In addition to its capacity to detect radial head malalignment it can display soft-tissue interposition at the fracture site and joint effusion within the radiocapitellar joint region [7, 13].

Classification

According to fracture patterns, Bado [1, 2] divided the Monteggia lesions into four groups. Independent of the fracture type, the ulnar shaft is always angulated to the same direction as the radial head is dislocated [17].

- Type 1: these injury patterns are characterized by an extension-type ulnar fracture with anterior displacement of the radial head. This fracture type is the most common among Monteggia fractures. It has been reported to account for about 60–85% [24].
- Type 2: in type 2 injuries, the ulnar shaft fracture is angulated posteriorly (flexion-type ulnar fracture). Consequently, the radial head is dorsally dislocated. These lesions account for about 10–15%.

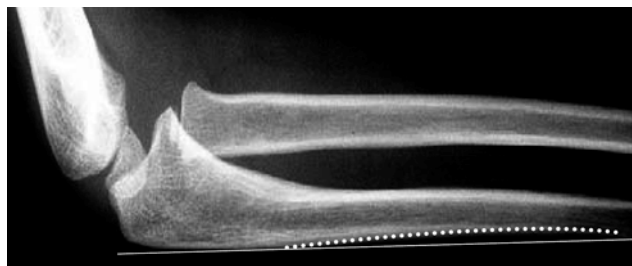


Figure 2. A straight line drawn along the dorsal aspect of the ulna is helpful for detection of radial head dislocation. Normally, the dorsal cortex of the ulna is not bent. If the dorsal cortex deviates from the straight line (bowing sign), ulnar deformation is probable. The direction of bowing also indicates the direction of radial head dislocation.

- Type 3: in type 3 Monteggia lesions, the ulnar shaft angulation and radial head dislocation are laterally. With an occurrence of about 5% they are rather uncommon.
- Type 4: type 4 lesions have essentially the same ulnar shaft fracture and radial head dislocation patterns as type 1 injuries, but with an additional proximal radial shaft fracture. Together with other fracture variations, they account for about 5%. According to reports in the literature, this injury pattern is present in the pediatric population more often than initially thought [16, 38].

Variations of the classic Monteggia lesions are also encountered which do not precisely fit into the Bado classification. From a clinical point of view, this classification might be more of descriptive than of therapeutic relevance in children.

Treatment

Concerning the appropriate treatment, it is important to distinguish between acute and missed Monteggia fractures with chronic radial head dislocation.

Acute Monteggia Fractures

Primary goal in the treatment of Monteggia fractures is the reposition of radial head dislocation, which can only be achieved, if the malalignment of the ulna is corrected. Since fracture treatment in childhood aims for the *avoidance of pain*, repositioning of the Monteggia fracture does usually necessitate *general anesthesia*. In acute Monteggia lesions, radial head reduction can normally be achieved by closed means. Consequently, open reduction is rarely indicated. In bowing fractures of the ulna, retention of the relocated radial head can be diffi-

cult. If retention of the radial head cannot be achieved, complete fracturing of the ulna is necessary. By restoration of ulnar alignment, radial head dislocation normally reduces spontaneously.

Surgical Treatment. One important change in the treatment of Monteggia lesions over the last years is the more commonly recommended surgical stabilization of the ulna. This aims for prevention of secondary displacement and consecutive radial head dislocation. Since general anesthesia is carried out at the time of primary reduction anyway, we feel that surgical stabilization should be performed. All complete ulnar fractures should be surgically stabilized as well, since (due to consecutive ulnar shortening) secondary displacement may occur.

This can be done in a minimally invasive method using an intramedullary elastic nailing technique with Prévot nails or Kirschner wires. Those are inserted percutaneously in an antegrade manner (Figures 3a and 3b). Main advantages of this method are shorter durations of immobilization and decrease of secondary complications. As mentioned, in greenstick fractures, bowing or incomplete fractures, remaining ulnar elasticity can prevent radial head retention during cast immobilization. Therefore, forces should be neutralized by completely fracturing the ulna. Furthermore, a prebent elastic nail can be helpful to protect retention of ulnar alignment and the radiocapitellar joint (Figures 4a to 4d).

In general, open reduction of the radial head in children with acute Monteggia lesions is rarely indicated. However, this might be unavoidable, if the radial head cannot be reduced by close means. This is particularly the case, if interposition of soft tissues (annular ligament) is present. An interposition of the annular ligament can be partial or complete. It may occur in the proximal radioulnar and/or the radiocapitellar joint. Furthermore, osteoarticular fragments may prevent the radial head from reduction. These fragments originate from osseous avulsions of the annular ligament. They are mainly encountered in type 2 injuries. Open reduction of the radial head and reconstruction of the annular ligament are accompanied by an increasing risk of functional deficits due to heterotopic ossification, scarring,



Figures 3a and 3b. a) Type 1 Monteggia fracture in a 7-year-old girl. Accident. b) Postoperative radiographs. Realignment of the ulna resulted in radial head reduction. Retention of the ulna with an elastic nail inserted percutaneously from antegrade.

and radioulnar synostosis. Therefore, indications for open radial head reduction have been considered with increasing skepticism [19].

Postoperative Management. After surgical stabilization of the ulna, immobilization is normally maintained until the time of stitch removal (5–8 days). **Implant removal:** in children, implants are generally removed. This should not be performed before radiologic union of the ulna. If implant-related complications (implant failure, wire perforation into the joint or through the skin, infection) occur, earlier implant removal and/or reosteosynthesis should be considered.

Conservative Treatment. Although conservative treatment is not the preferred treatment of choice, parents, however, have also to be informed that it remains a therapeutic option. If conservative treatment is carried out, the risk of secondary displacement and reoperations is, in our experience, higher. For nonoperative treatment, repositioning maneuver and aftercare are adjusted to the fracture type. In order to reduce the risk of compartment syndrome, cast immobilization should preferably be performed as posterior splint.

Type 1. For reduction, longitudinal traction to the forearm is applied simultaneously to full supination. The elbow joint is flexed around 110° in order to decrease tension of the biceps muscle. The dislocated radial head is then repositioned by manual pressure from anteriorly. This is also possible, if the radial head is not



Figures 4a to 4d. a) Type 1 Monteggia fracture in a 7-year-old boy. Accident. b) Intraoperative situation. After realignment of the ulna and repositioning of the radial head dislocation, a tendency to redislocation due to the remaining ulnar elasticity was noticed. Consequently, a prebent elastic nail was inserted. During insertion, the bowing of the nail is congruent with the ulnar bowing. After insertion, the nail is turned 180° around its longitudinal axis, resulting in a more stable situation. c) Postoperative radiographs revealing correct retention of the lesion. d) Radiographs 3 weeks postoperatively.

palpable. Once the radius is reduced, correction of the angulated ulnar shaft is carried out. This is generally not difficult. Although redislocation of the radial head is unlikely to occur as long as the elbow is kept in flexion, radiographic control of the accuracy of the reposi-

tioning maneuver is essential. The forearm is then immobilized in about 100–120° of flexion. Forearm rotation is kept in neutral position or in minimal supination.

Type 2. The posterior Monteggia fracture is usually reduced by application of traction and full extension of the elbow joint. With slight manual pressure from posteriorly, the radial head is normally easily reduced. The posterior ulnar angulation is then corrected. After complete repositioning of the radial head, the elbow should be flexed and extended. In general, reduction of the radial head is held, if there is no interposition of the annular ligament. Additional stability is gained by stable reduction of the ulnar angulation. Although it has been stated in the literature that restoration of the ulnar angulation does not need to be totally anatomically corrected after the radial head dislocation is reduced [24], we feel that the tendency to redislocation increases with the degree of remaining ulnar malalignment. However, the main emphasis should lie on the exact repositioning of the radiocapitellar joint. If this is functionally stable during a full range of motion, a remaining ulnar deviation of 5–10° can be tolerated. This normally results in spontaneous correction and remodeling of the ulna without remaining functional impairment of the elbow joint. Immobilization of type 2 lesions should be done in almost full extension of the elbow and slight supination of the forearm.

Type 3. In cases of lateral ulnar angulation and dislocation of the radial head, slight varus stress should first be applied to the forearm. After application of lateral manual pressure, the arm should be put into valgus stress while the manual pressure is still continued. Reduction of the radial head should then be unproblematic.

Radiographs should always be obtained to ensure proper placement of the radial head. Especially in this type of injuries, reassessment of the neurologic status is mandatory, since neurologic deficits of the radial nerve are frequently encountered [24].

Type 4. The type 4 lesion is very rare. Consequently, recommendations for its treatment do not base on larger series. However, we feel that osteosynthesis of the radius is desirable, since otherwise the remaining instability might make retention of the radial head complicated or even impossible.

Immobilization. Immobilization during conservative treatment is maintained until osseous union of the ulna is radiologically noted. Depending on the patients' age, this generally takes between 4 and 6 weeks. A clinical and radiologic follow-up should be obtained after 1 week in order to recognize secondary radial head dislocation or axial malalignment of the ulna. If this is encountered, realignment is normally achieved by wedging the cast or by closed reduction (analgesia) and application of a new cast. Open reduction and osteosynthesis is seldom necessary. It should be pronounced, that ulnar realignment and radial head reduction become increasingly difficult at later follow-ups. At the time of cast removal, a radiologic follow-up is performed to confirm consolidation and to ensure correct alignment of the radiocapitellar joint. If callus formation at this time is indolent, full range of motion can be initiated. Physical exercise in school can be allowed after 6 weeks. Physical therapy is generally not necessary. Unrestricted range of motion is normally regained 6 weeks after osseous consolidation. However, further follow-ups are recommended for 1–2 years after trauma.

Accompanying Proximal Radius Fracture. If an accompanying fracture-dislocation of the proximal radius is diagnosed, manual fracturing of the greenstick or bowing fracture of the ulna is indicated. Proximal radial fracture is then treated according to the guidelines of isolated radial head/neck fractures. *Periosteal avulsion of the annular ligament:* normally, failed retention of the radial head is rather the result of an insufficient realignment of the ulna than of the ruptured annular ligament. If periosteal avulsions of the annular ligament do not prevent proper reduction of the radial head, surgical correction is not indicated. Periosteal avulsions have the tendency to anatomically relocate, if anatomic reduction of the radial head and axial alignment of the ulna are achieved. Significant impairment in range of motion, caused by developing periligamentous callus formation, is normally not encountered. In cases of completely displaced unstable *oblique ulnar fractures*, v. Laer formerly recommended open reduction of the ulnar fracture and plate osteosynthesis for ulnar realign-

ment. Recently, however, less invasive dynamic nailing techniques have preferably been performed [19].

In our opinion, neither in chronic radial head dislocations nor in acute Monteggia fractures temporary radiocapitellar or radioulnar transfixation using K-wires, as formerly recommended by Witt [43], is indicated for radial head retention. This method is not taking the *reason* for radial head dislocation, which is the ulnar malalignment, into account. Consequently, the redislocation rate and the likelihood of implant failure are high (see Figures 5b and 5c).

Complications. It has to be emphasized that the main prerequisite for avoidance of complications is early and correct recognition of the injury pattern. Untreated Monteggia fractures may result in diminution of range of motion, instability or valgus deformity of the elbow. After dislocations or fracture-dislocations of the radial head, malformation of the radial head with development of radiocapitellar incongruity can occur [19]. However, this does not generally interfere with forearm rotation.

Reports in literature on the incidence of acute nerve injuries vary significantly. Acute neurologic deficits between 3% [5] and 50% [34] are reported. They do most often involve the radial and the posterior interosseous nerves, but may also concern the ulnar and median nerves. In type 3 fractures, associated radial nerve injuries are more often encountered. Remaining neurologic deficits are rare. Spontaneous recovery can be expected in 80–100%. Therefore, surgical interventions for nerve exploration are seldom indicated.

Heterotopic ossification may also occur after Monteggia fractures. It appears either as periarticular ossification, myositis ossificans, or radioulnar synostosis. Its occurrence is related to severity of injury, amount of soft-tissue damage, and number of manipulations [34]. In these cases, surgical intervention is only indicated, if significant functional impairment is encountered (radioulnar synostosis after reconstruction of annular ligament).

Arthrolysis. The rate of posttraumatic functional impairments following acute Monteggia lesions is low. If severe capsular adhesions or calcifications occur, a considerably decreased range of motion can develop. Further causes of impaired elbow function are radioulnar synostosis, radial or ulnar exophytes, and severe radial head or neck deformities. In these cases, an arthrolysis may be indicated. The surgical procedure of an arthrolysis is demanding and extensive and should

therefore only be performed by experienced surgeons. Consequently, the indication for this procedure should be based on the degree of impairment and patients' motivation. It is important to take into account that functional improvements are possible even after periods of ≥ 1 year. Therefore, the surgeon should rather be restrictive in considering early arthrolysis. In our opinion, the procedure should be performed not earlier than 1 year after trauma. Criteria justifying open arthrolysis are impairment in elbow flexion/extension of $\geq 50^\circ$, decreased forearm rotation of 50° for pronation and 60° for supination. Preoperative CT scans are helpful in localizing the cause of limitation and for choosing the approach. Normally, a wide posterior or lateral approach (allowing posterior and anterior capsulotomies) provides sufficient access. All adhesions and exophytes around the radial head are excised. Accompanying osteotomies should not be performed, since they might alter the essential intensiveness of postoperative physical therapy. It is crucial in these cases that physical therapy is initiated not later than 2 days after surgery in order to prevent new adhesions. Patients < 12 years are far less likely to benefit from arthrolysis. Consequently, younger children should not be treated by these means.

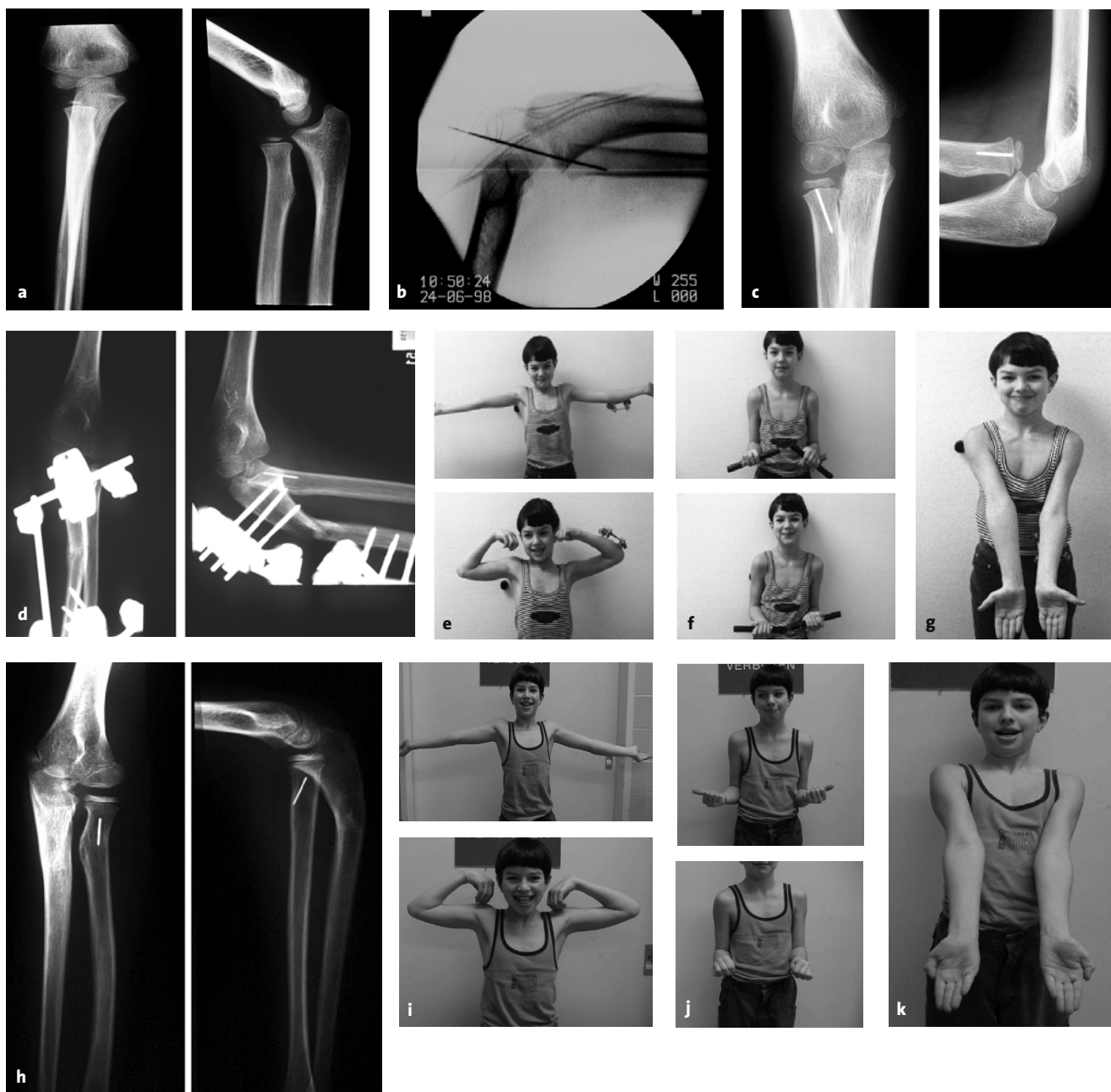
Prognosis. The prognosis of acute Monteggia lesions, which are diagnosed early and treated properly, is generally very good. Most of the children regain their full elbow function already 6 weeks after operative treatment or cast removal.

Missed Monteggia Lesion/Chronic Radial Head Dislocation

The fact that the more obvious ulnar shaft fracture pulls the attention frequently away from the elbow, missed radial head dislocation or incomplete dislocation is not uncommon. Although reliable data on the incidence of missed Monteggia lesions are not known, this complication represents the most common posttraumatic deformity following Monteggia lesions. Even though complications after acute Monteggia fractures are seldom, their occurrence increases significantly with delayed detection of Monteggia fracture patterns. In the past, delayed reconstruction after missed Monteggia lesions did not always lead to satisfying functional results [8, 14, 15]. Therefore, indications for surgical intervention have been considered critically. However, mild subjective complaints in untreated missed Monteggia lesions in childhood can result in considerable complaints later on. Due to radial head deformities and consecutive ra-

diocapitellar arthrosis, radial head resection might then be necessary. In recent times, the opinion on surgical intervention of missed Monteggia lesions in childhood has therefore changed. Since the chances of successful surgical intervention in adult patients are significantly smaller than in children (capability of postoperative remodeling), surgical reconstruction should be done in childhood, the sooner the better. Concerning forearm rotation, pronation deficits have a higher impact on elbow function than supination deficits. In cases of missed Monteggia lesions, spontaneous "near anatomic" correction of primary ulnar axial malalignment is often noted. However, radial head dislocation remains and functional impairments are common. Most authors in the literature agree about the necessity of reconstruction of radial head dislocation by performing ulnar corrective osteotomy. A further problem is that, after several years, a discrepancy between the radial and ulnar lengths is encountered. This can be the cause for additional complaints within the distal radioulnar joint. Consequently, the aim of surgical intervention is not only restoration of the anatomic ulnar axis with realignment of the radiocapitellar joint, but also restoration of the anatomic length of the ulna. This is, however, technically very demanding, since preoperative planning of the procedure must be performed three-dimensionally, although it is based on two-dimensional radiographs. Definition of the appropriate plane for correcting the ulnar axis is difficult. Finding this plane from dorsal and stabilizing the ulna by plate osteosynthesis, nailing or distraction osteotomy [11] is not a generally accepted method, since the results achieved are rather disappointing. However, ulnar osteotomy and plate osteosynthesis is often used for ulnar realignment.

Von Laer [19] stated, that only the repositioned radial head is "capable of defining the appropriate position for ulnar realignment". He recommended the following method: an external fixator allowing three-dimensional correction is applied to the ulna. At the proximal ulnar fragment, the fixator is positioned as proximal as possible. Then, ulnar osteotomy is performed. This is followed by open radial head repositioning and removal of all interpositioning soft tissues which, generally, are remains of the radial annular ligament. Using a blunt Hohmann retractor, the radial head is retained. While the external fixator is opened, full pronation of the forearm is performed. At this position, the external fixator is locked. Full supination is performed, keeping the fixator locked. If this results in



Figures 5a to 5k. Missed Monteggia lesion in an 8-year-old boy.

a) Initial radiographs revealing chronic radial head dislocation.

b) Insufficient treatment using a transarticular K-wire. As shown, radiocapitellar transfixation does not provide adequate retention.

c) 3 weeks after transfixation, part of the K-wire had to be removed due to implant breakage.

d) According to the technique described by v. Laer [19], surgical revision with ulnar osteotomy and application of an external fixator was performed.

e) Postoperative situation: almost full range of motion in extension and flexion.

f) Only slightly diminished range of motion in pronation and supination.

g) Correct axial alignment is achieved.

h to k) Excellent functional results 2.5 years after secondary intervention.

complete or incomplete dislocation of the radial head, the fixator is opened, while the radial head is pushed back into position. Then, the fixator is locked in full supination again. This procedure is also repeated for extension and flexion of the elbow. One position of the ulnar osteotomy will then result in stable radial head retention without dislocation tendency during movements. By using this method, stable radial head retention is very often achieved in an angulated position of the ulna with a slight rotation of the fragments to each other (Figure 5). Using this procedure, good results have been reported [19]. Reconstruction of the annular ligament in chronic Monteggia lesions is normally not necessary. It should be emphasized, that children with no complaints and a free range of motion should not be operated on.

Timing of Corrective Surgery. Missed radial head dislocations should be treated as soon as possible. Functional deficits are mainly due to radial head deformities originating from unphysiological loading (incongruity of radiocapitellar joint). For radial head deformities as well as varus angulation deformity of the ulna, maturation of the bone (closed growth plates) should be complete before reconstruction. Also for radial head resection, it is of importance to postpone intervention until growth plates are closed. Otherwise, radial head overgrowth can occur, necessitating secondary radial head resection.

Prognosis. In contrast to early diagnosed acute lesions, functional results in missed Monteggia lesions or chronic radial head dislocations are not always optimal and subjective complaints are significant. It is known that secondary interventions for repositioning of the radial head in the settings of a missed Monteggia lesion result predominantly in unsatisfying functional outcomes [19, 31, 37, 41]. Former reports on good functional results, as stated by Lloyds-Roberts & Bucknill [22], were considered exceptional [24]. However, newer techniques, as described by v. Laer [19, 20], are promising concerning the long-term prognosis. Although scientific data on the real prognosis in these cases are not available, it must yet be assumed, that delay of adequate treatment, repeated surgery, remaining radial head dislocation, and radial elbow instability have a negative impact on the functional results following Monteggia lesions.

Conclusion

Monteggia fractures in childhood are rare injuries. Early recognition of the combination of ulnar fracture with radial head dislocation is crucial. Any fracture or angu-

lation of the ulna should thoroughly be checked for any complete or incomplete dislocation of the radial head. Radiocapitellar congruity is evaluated by AP and true lateral X-rays, in which the radiocapitellar joint line must be intact in both views. The aim of any form of treatment must be repositioning and retention of radial head and restoration of ulnar alignment. Recently, surgical treatment has become more important for achieving good functional results and for avoiding secondary corrective surgery. For the majority of acute Monteggia lesions, immediate repositioning maneuvers with surgical stabilization of the ulna (elastic nailing techniques) under general anesthesia are indicated. Cast immobilization is short; physical therapy is normally not necessary. Frequent radiographic reevaluation is mandatory. In acute Monteggia lesions, functional results are predominantly very good. In missed Monteggia lesions or chronic radial head dislocations, functional results are inferior. Nevertheless, newer surgical techniques for secondary correction of the ulnar malalignment are promising. However, corrective surgery in these patients is demanding and should only be performed by experienced surgeons.

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