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Editorial

Fractures of the Radial Head Following Posterior Elbow Dislocation in Children: Classification of the Reduction Type Injury

NK Sferopoulos*

Department of Pediatric Orthopaedics, "G. Gennimatas" Hospital, Thessaloniki, Greece

***Corresponding Author:** NK Sferopoulos, Department of Pediatric Orthopaedics, "G. Gennimatas" Hospital, Thessaloniki, Greece.

Received: September 29, 2022; **Published:** September 30, 2022

Two types of radial head fractures associated with posterior elbow dislocation in children have been described in the literature. The dislocation type injury occurs during the process of a posterior dislocation of the elbow. The capitellum applies a proximal force to the distal lip of the radial head displacing the radial head anteriorly to the radial metaphysis and often parallel to the long axis of the radial diaphysis. It can be diagnosed either in an unreduced or in a spontaneously reduced posterior elbow dislocation. The reduction type injury occurs during reduction, either spontaneous or manual, of a posterior dislocation of the elbow. The proximal radial epiphysis fractures off against the inferior aspect of the capitellum, is tilted 90° posteriorly and is entrapped in the posterior aspect of the joint beneath the interposed capitellum with the articular surface facing inferiorly [1-6].

Various classification schemes of proximal radial fractures in children have been presented in the literature. Although the reduction type injury is a very rare injury in children, it has been included in all classification systems. Accordingly, the reduction type injury may also be defined as a Jeffery type 2 lesion [7,8], as a Newman group II injury [9], or as a Wilkins type D fracture [10-12].

The reduction type injury is thought to be due to a rotational movement of the radial head, during reduction, about a posterior periosteal hinge, which remains intact postinjury. The mechanism of injury may be compared with that of a bottle-opener. This may explain the constant radiographic appearance of the radial head in the posterior aspect of the joint, with the capitellum interposed between the radial head and the decapitated radial neck. This radiographic finding has been considered pathognomonic of the reduction type injury (Figures 1,2). The main risk of the reduction type lesion is to miss the diagnosis of the displaced radial head on plain radiographs (Figure 3). The diagnosis of the reduction type injury when the radial head is not yet ossified is still a challenge. A small displaced flake of the metaphysis may be the only radiographic finding of the lesion. The diagnosis of hemarthrosis (with fat pad sign) of the elbow without an evident fracture in children younger than 5 years of age needs further imaging investigations, such as ultrasonography, arthrography, or magnetic resonance imaging [13].

The reduction type lesion may present in children following either a spontaneously reduced transient posterior elbow dislocation or as an iatrogenic lesion, during manual closed reduction of a posterior dislocation of the elbow in a child with an intact proximal radius. The latter type of injury could also be encountered in children suffering from a posterior elbow dislocation associated with an undisplaced fracture of the radial neck. Therefore, posterior elbow dislocation in children requires careful radiographic investigation before reduction, looking for a radial head fracture without displacement (intermediate stage of the reduction type injury), in order to prove that the fracture occurred at the time of injury and not during external manipulation for reduction of the elbow dislocation. Careful use of reduction techniques in children suffering from posterior elbow dislocation, using procedural sedation and avoidance of repeated forceful manipulations should be emphasized [13-17].

Successful closed reduction of the injury has only scarcely been reported in the literature, therefore, it may be prudent to consider closed manipulation of the entrapped radial head in the posterior aspect of the joint beneath the interposed capitellum as almost impossible [18,19]. The risk of reversal of the radial head makes warns against closed external manipulation, recommending direct open reduction, sound reasonable [20,21]. The fully turned radial head, with the smooth articular surface facing distally and the metaphyseal part facing the joint space has been defined as the 'upside-down' radial head. The 180º rotation of the radial head could result in avulsion of the periosteal flap (if present) and consequently to avascular necrosis of the epiphysis [22]. Therefore, the treating physician should be aware of this potential complication, even in the absence of a complete posterior elbow dislocation and must be able to read closely and thoroughly good quality radiographs. It also seems imperative to obtain radiographs in the operating theatre because once the arm is in plaster it is difficult to secure the accuracy of reduction or fixation. Children with neglected reversal of the radial head are usually complicated by nonunion of the fracture [23-31].

Open reduction of a displaced radial head fracture is generally avoided in children, because of increased chance to develop growth disturbance and proximal radioulnar synostosis. Operative reduction should be reserved for intraarticular fractures that cannot be reduced by closed manipulation and in cases with posterior displacement of the radial head associated with capitellum interposition [32-34]. It has already been concluded that in severe cases of proximal radial fractures, open treatment does not necessarily decrease the risk of a poor outcome [35-37]. The use of a condyloradial K-wire, temporarily transfixing the elbow joint, may be associated with a high incidence of complications and intramedullary nailing and/or percutaneous pinning, using an oblique extraarticular K-wire, is preferred by most pediatric orthopaedic surgeons [38-42]. Soft-tissue injury associated with repeated attempts of closed reduction as well as the increased operative time may lead to or worsen forearm compartment syndrome [43].

In theory, complete rotational displacement of the radial head considerably increases the risk of avascular necrosis because of damage caused to the periosteal links. During displacement of the reduction type injury, a metaphyseal periosteal flap often remains attached to the radial head. Preservation of this sleeve, which contributes to the vascular supply of the radial head, is critically important to preserve the blood vessels it contains and because, once tensioned, this piece of tissue will assist in maintaining the reduction [22]. But even if the head is free of all periosteal attachments, it must still be replaced in children and should never be sacrificed. It has been shown that excision of the radial head in the growing child is a destructive procedure [44-48].

It has been strongly stressed that the reduction type fracture of the radial head following posterior elbow dislocation should be differentiated from radial neck fractures with posterior displacement and/or angulation but without capitellum interposition (Figure 4). The mechanism of injury includes valgus strain (mechanism Jeffery type 1) on a forearm in pronation, and there is no fixed point around which the displacement occurs. Such cases are always associated with a radiographically evident fracture of the olecranon. They may also rarely appear associated with posterior dislocation of the elbow but displacement of the radial head is effective on the radiographs while the elbow is not yet reduced [13].

The use of classification schemes in pediatric orthopaedic trauma is a valuable aspect to evaluate the mechanism of injury, to determine the optimal treatment and to predict a potential prognosis as well as to describe fracture types for practice and research [49,50].

A single type of radial head fracture during reduction of a posterior elbow dislocation in children has been described so far in the literature. Two inclusion criteria have been previously suggested to diagnose the lesion. They include: (a) the radiographic appearance of the separated radial head with a 90° posterior tilt lying beneath the capitellum, indicated as a capitellum interposition between the fragments, and (b) the injury is due to a rotational movement of the head (during the injury) about a fixed point represented here by the posterior periosteal hinge. However, it may be reasonable to consider that this periosteal attachment on some cases may be ruptured. In such a case, capitellum interposition would also be radiographically evident, although the separated radial head could be detected in any place beneath or even behind the distal humerus. Therefore, it may be mandatory to reconsider the second criterion.

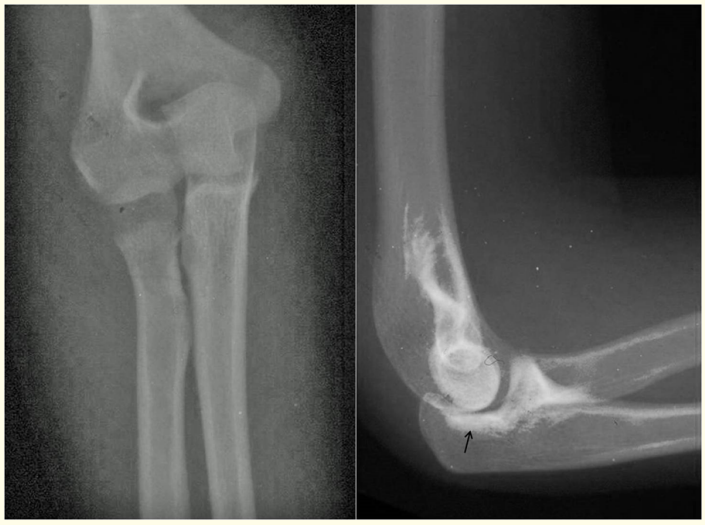

Figure 1: *A 14-year-old girl injured her elbow after a long jump. Full-blown picture of the radial head, as originally described by Jeffery, was evident on the anteroposterior view. Lateral radiograph indicated 90° posterior rotation of radial head (arrow) with the articular surface facing inferiorly and capitellum interposition, pathognomonic of a Jeffery type 2 injury.*

Figure 2: *A 14-year-old girl injured her elbow after a fall from a bicycle. Radiographs indicated a Salter-Harris type III fracture of the radial head. Capitellum interposition was pathognomonic of a Jeffery type 2 injury. The anterior lip of the radial head was intact, indicating that the forearm was rotated during the reduction of the elbow dislocation. The radial head fragment appeared intraoperatively as a loose intraarticular body.*

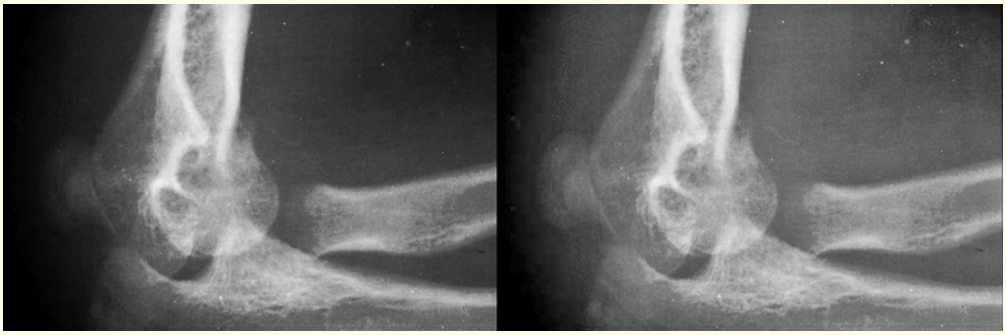

Figure 3: *The diagnosis of a displaced fracture of the radial neck was missed on the initial radiological examination of this 13-year-old girl who felt from a horizontal bar. The lateral radiograph was lighted up to indicate the displaced radial head behind the distal humerus.*

Figure 4: *A 10-year-old boy injured his elbow after a fall from a height. Initial radiographs indicated a posteriorly displaced and angulated fracture of the radial neck associated with a displaced fracture of the olecranon. There was no capitellum interposition between the radial fragments.*

This is the first attempt to describe a more inclusive classification scheme of pediatric fractures of the radial head following reduction of a posterior elbow dislocation. Therefore, two types of injuries may be described:

- Type I lesions: An intact metaphyseal periosteal flap between the fragments is detected intraoperatively.
- Type II lesions: No metaphyseal periosteal flap between the fragments is evident intraoperatively. In all cases the radial head fragment appears as an intraarticular loose body moving freely in the elbow joint.

Experience gained at our institution emphasizes that both types of injury may occasionally appear radiographically similar. However, it may be prudent to consider that in some cases with a displaced radial head beneath the capitellum, the metaphyseal periosteal flap may be ruptured. Therefore, the treating surgeon should always be alert that a completely devoid of periosteal attachment radial head may be evident intraoperatively, necessitating the outmost cautious and secure handling of the proximal radial fragment during the surgical approach of the elbow joint. The suggested system of classification may also provide critical information on treatment outcome and prognosis, indicating the potential higher incidence and severity of complications, such as avascular necrosis of the radial head, premature physeal closure, periarticular ossifications and proximal radioulnar synostosis, detected in type II lesions.

Conclusion

A classification system for the reduction type fracture of the radial head following posterior elbow dislocation in children is presented. A new type of injury that is referred as a type II lesion is presented in this editorial. In this type of injury, displacement may occasionally be wide since no intact periosteal hinge is left, and the proximal radial fragment appears as an intraarticular loose body located beneath or even behind the distal humerus. Diagnosis of this traumatic lesion may also be considered as a valuable predictor of potential severe complications and subsequently of a poor final clinical outcome.

Conflict of Interest Statement

The author certifies that he has no commercial associations (such as consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article. The author received no financial support for this study.

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Volume 13 Issue 9 September 2022