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# Pediatric Proximal Radius Fracture and Reduction Techniques: An Educational Review

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## Background

Pediatric radial neck fractures are rare, comprising about a tenth of all elbow injuries in children (1). They typically affect the children between 4 to 14 years of age with a peak of incidence ranging between 8 and 10 years of age (2). Because radial head ossification starts at age 5 and is completed when the physis closes at 14 years of age for boys and 17 for girls (3). The most common mechanism of this fracture is falling over an outstretched extended hand with a valgus force (4). The most common radial neck fractures are extra-physeal fractures of the metaphysis or Salter-Harris I or II fractures of the proximal radial physis (4). Closed fractures are more common than open ones and near half of these fractures are associated with the ipsilateral elbow dislocation, olecranon fractures, and ruptured collateral ligaments (5). The classification systems in radial neck fractures including the Jeffery, O'Brien, and Judet and Letournel classification systems are the most commonly cited ones in the literature (3).

The management of radial neck fractures is based on fracture angulation, dislocation , and skeletal maturity (6). Treatment options that have been used for fractures with dislocation are closed reduction, percutaneous pin-assisted reduction, Metaizeau technique (elastic intramedullary nailing), and if these closed methods are not successful, open reduction with or without internal fixation can be used (6). Although good results have been reported after these varying treatment methods, the optimal treatment is still unclear (7).

## Classification

In 1965, O'Brien originally classified these fractures based on angulation and recommended treatment options (8) (Figure 1).

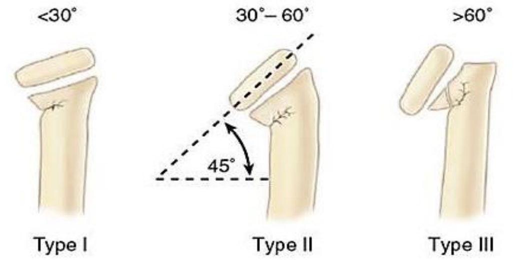


**Figure 1.** O'Brien classification: Type I: angulation < 30 degrees (immobilized), Type II: angulation 30 to 60 degrees (closed reduction), Type III: angulation > 60 degrees (open reduction)

Chambers classified proximal radial fractures into three major groups based on the mechanism of injury and the radial head dislocation (Table 1).

**Table 1.** Chambers classification of proximal radial fractures

| |
|---|
| **Group I: Primary displacement of radial head** |
| A. Valgus fractures |
| Type A: SH I or II injury |
| Type B: SH IV pattern |
| Type C: Fracture line remains in metaphysis |
| B. Fractures associated with dislocation |
| Type D: Reduction injuries |
| Type E: Dislocation injuries |
| **Group II: Primary displacement of radial neck** |
| A. Angular injuries (Monteggia type III variant) |
| B. Torsional injuries |
| **Group III: Stress injuries** |
| A. Osteochondritis dissecans of the radial head |
| B. Physeal injuries with neck angulation |

Radial neck fractures, the most common type of proximal radius fractures, (Group IA and IC) have also been classified based on the amount of angulation by Judet (Figure 2).

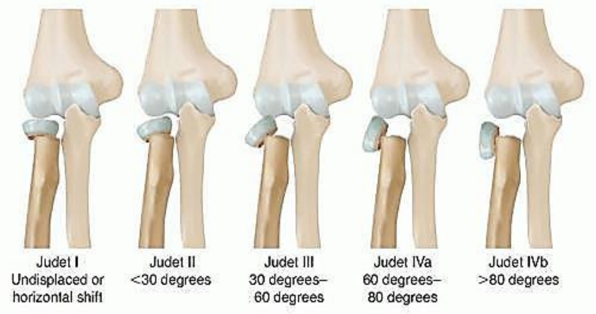


**Figure 2.** Judet classification: Type 1: 0° with translation, Type 2: < 30° epiphyseal tilt, Type 3: 30°-60° epiphyseal tilt, Type 4a: 60°-80° epiphyseal tilt, Type 4b: > 80° epiphyseal tilt

## Examination

Examination of a proximal radial fracture will reveal tenderness to palpation at the proximal radius and pain with elbow motion, particularly with attempted supination and pronation, which the patient will avoid. Ecchymosis and bruising in the lateral aspect of the elbow can be predicted for fracture dislocation (9).

A good clinical examination helps to localize the area most likely to be fractured before an x-ray (8).

### Imaging

Displaced proximal radius fractures are usually easy to identify on standard anteroposterior (AP) and lateral radiographs (Figure 3).

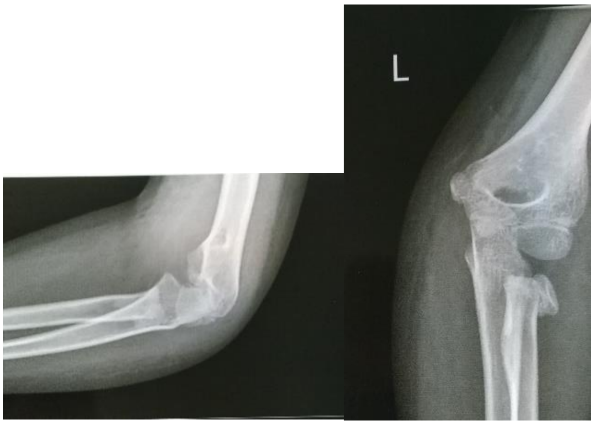


**Figure 3.** Significantly displaced radial neck fracture

Contralateral elbow X-ray views are useful for the assessment of the unusual ossification centers after an acute elbow injury. If there is any limitation in elbow extension because of pain, special views are necessary to see the AP alignment of the proximal forearm and distal humerus. Two views are taken by beaming perpendicular to the distal humerus and the other perpendicular to the proximal radius. There are useful modalities such as an arthrogram, ultrasound, or magnetic resonance imaging (MRI) to evaluate the dislocation and the reduction quality in cases with an unossified radial epiphysis (10). Multidetector computed tomography (MDCT) is a sensitive means of evaluating for radiographically occult fractures in children with post-traumatic elbow effusions. It has a high negative predictive value and a high level of inter-observer agreement. MDCT findings may lead to alternate treatment in children with no displaced lateral condylar and radial head fractures on radiography (11) (Figure 4).


**Figure 4.** Multidetector computed tomography (MDCT): Radial neck fracture in a 12-year-old boy

### Associated Injuries

Associated injuries occur in 30 to 50 percent of patients with a radial neck fracture. These additional injuries include fractures of the olecranon (12), proximal ulna, medial and lateral epicondyle, ruptures of the medial collateral ligament, and shear injuries to the articular cartilage (8, 13). The posterior interosseous nerve (PIN) can be injured by the fracture, by reduction attempts, or during an open reduction (14).

### Complications

Pediatric radial neck fractures are accompanied by a high incidence of complications, with reported rates ranging from 18 to 79%. stiffness is the most common complication (7).

### Non-Operative Treatment

Non-operative methods are the main part of treatment for proximal radius fractures (15). Less than 30 degrees of angulation (Judet type I and II) and 3 mm dislocation in children with normal supination and pronation can be treated with splint without any try for reduction (4, 5, 7, 16). Most authors have advocated for closed reduction for fractures with an angulation greater than 30°, although there have been recommendations for closed reduction of angulations ranging from 20° to 45° (17).

The presence of full pronation and supination under local or general anesthesia may be more important to the patient’s clinical outcome than the degree of angulation and translation saw radiographically (4, 8).

### Closed-Reduction Technics

No technique has been demonstrated to have superiority over the others. Various closed reduction techniques have been developed for radial neck fractures based on manipulating the proximal fragment to the fixed radial shaft or trying to reduce the fracture by fixing the proximal fragment and manipulating the radial shaft. We would like to caution that multiple attempts at closed reduction can lead to increased injury, bleeding, and later stiffness (4).

The Patterson technique involves traction and a varus force applied to the forearm, while direct pressure is applied over the radial head (18) (Figure 5).

**Figure 5.** Patterson technique: Holding the elbow in extension while applying distal traction and varus stress on a supinated forearm with direct pressure over the radial head

The Israeli technique uses supination of the maximally flexed elbow to relieve capsular tension while direct pressure is applied over the radial head from the lateral side. The forearm is then gently pronated to rotate the radial head under the applied pressure and reduce it (18) (Figure 6).

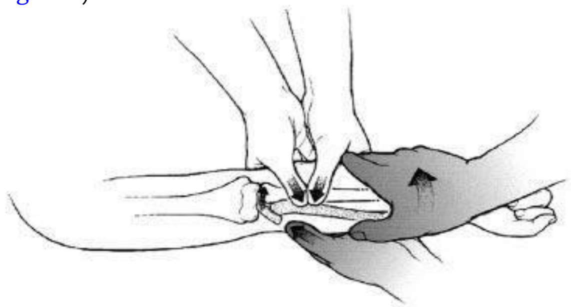

**Figure 6.** Israeli technique: Pronating and flexing the supinated and extended elbow while the thumb stabilizes the proximal radial fragment with direct pressure

Neher and Torch described a technique that begins by rotating the forearm under fluoroscopy until the AP view with maximal angulation is obtained with the elbow in extension. While a direct force and varus stress are applied to the radial head by the surgeon, an assistant applies a force that is directed laterally to the anterior proximal head of the radius to serve as counter reduction. Finally, the application of an elastic (Esmarch) bandage from the distal forearm to the elbow has been described to result in the serendipitous reduction of the radial neck, however despite being frequently mentioned in textbooks, the technique lacks validation in the literature (19).

**Operative Treatment Indications**

Operative methods indicate cases with unacceptable dislocation (over 2 mm after close reduction) and angulation (greater than 45 degrees for cases below 10 years old and greater than 30 degrees in cases older than 10 years old) and for the open injuries (20).

**Percutaneous-Reduction and Fixation Technics**

Percutaneous (PC) assisted reduction is the first step if closed reduction is not successful. In this method, the fragment is manipulated with K-wire or elevator or using the Metaizeau technique (5).

Simple stainless steel K-wires generally are appropriate to assist with closed reduction. The size will range from 2.0 to 2.7 mm based on the size of the child. Other utilized instruments include Steinmann pins, periosteal elevators, or a double-pointed bident (21-23). Fluoroscopy is used to localize the fracture site and a small curved clamp is utilized to bluntly dissect through the muscle to the radial cortex.

Arthrography can be helpful to assess congruency of the elbow joint (24). The sharp end of the wire is cut for the surgeon's safety and the blunt end is inserted down to the radial cortex. The blunt end of the wire can be used to push the distal fracture fragment back into an appropriate position (25). Once the fracture is reduced to within the appropriate guidelines, the pin is removed and stability and range of motion (ROM) are assessed. In unstable fractures, the internal fixation can be used. Small ante-grade K-wires can be placed percutaneously to transfix the fracture.

One option is the leverage method (direct manipulation of the fragment) using a small PC incision, followed by placement of the blunt side of a large Steinman pin, or Freer elevator (26). The wire should be inserted from the dorsal aspect of the distal and the forearm should be pronated for the PIN protection. Once the fragment is levered up, closed reduction maneuvers are performed. The reduction is usually stable, but PC fixation can also be performed if needed.

The joystick method is a method in which the surgeon inserts a Steinman pin or Kirschner wire directly to the radial head to maneuver the head to the shaft (Figure 7). The forearm in this technique should also be pronated to protect PIN. In our experience, the leverage maneuver was easier as there was no difficulty removing the "joystick" pin (27).

**Figure 7.** Steinman pin in joystick method

Another option is the Metaizeau technique (flexible intramedullary nail). Using the bender, a curve is made in the tip of the nail and then the nail is inserted from the dorsal aspect of the distal radius in a physial friendly fashion into the radial head. When the nail tip reaches the fragment, its manipulation can be started to realign the proximal radius fracture. The nail is retained for added stability (Figures 8 and 9).

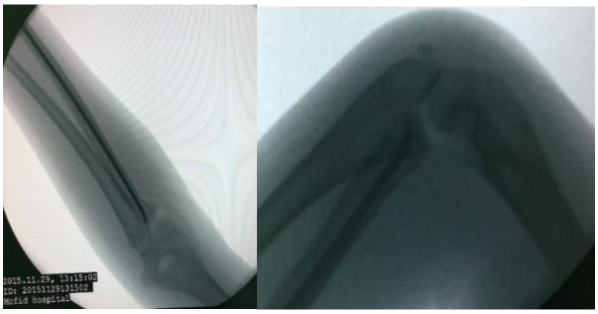

**Figure 8.** Fluoroscopic reduction and percutaneous fixation with intramedullary nail in a child applied with Metaizeau technique

In more severely angulated and displaced fractures, a combination of these two techniques can be performed (5).

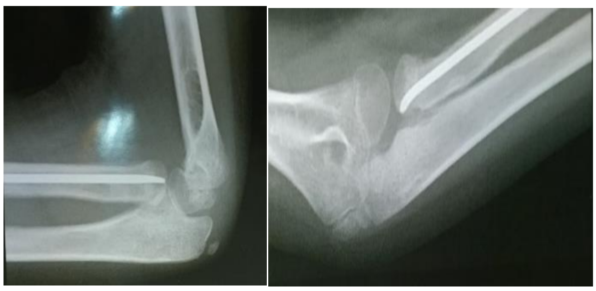

**Figure 9.** Final reduction and fixation with intramedullary nail in Metaizeau technique

### *Conclusion*

It is important to know the basic management of pediatric proximal radius fractures to prevent complications. In this paper, we described classifications of pediatric proximal radius fractures, in addition to explaining closed reduction techniques with or without internal fixation.

## Conflict of Interest

The authors declare no conflict of interest in this study.


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## References


1. Kumar S, Mishra A, Odak S, Dwyer J. Treatment principles, prognostic factors and controversies in radial neck fractures in children: A systematic review. *J Clin Orthop Trauma*. 2020;11(Suppl 4):S456-S463. doi: 10.1016/j.jcot.2020.04.022. [PubMed: 32774012]. [PubMed Central: PMC7394816].
2. Yallapragada RK, Maripuri SN. Radial neck fractures in children: A surgical tip using the Metaizeau technique to improve stability of the reduction. *J Orthop*. 2020;17:127-33. doi: 10.1016/j.jor.2019.06.001. [PubMed: 31879491]. [PubMed Central: PMC6919370].
3. Colozza A, Padovani S, Caruso G, Cavaciocchi M, Massari L. Arthroscopically-assisted reduction and pinning of a radial neck fracture in a child: A case report and review of the literature. *J Med Case Rep*. 2020;14(1):78. doi: 10.1186/s13256-020-02390-0. [PubMed: 32580779]. [PubMed Central: PMC7315511].
4. Nicholson LT, Skaggs DL. Proximal radius fractures in children. *J Am Acad Orthop Surg*. 2019;27(19):e876-e886.doi: 10.5435/JAAOS-D-18-00204. [PubMed: 30865025].
5. Shabtai L, Arkader A. Percutaneous reduction of displaced radial neck fractures achieves better results compared with fractures treated by open reduction. *J Pediatr Orthop*. 2016;36(Suppl 1):S63-S66. doi: 10.1097/BPO.0000000000000763. [PubMed: 27100035].
6. Shah MM, Gupta G, Rabbi Q, Bohra V, Wang KK. Close reduction technique for severely displaced radial neck fractures in children. *Indian J Orthop*. 2021;55(1):109-15. doi: 10.1007/s43465-020-00168-6. [PubMed: 33569104]. [PubMed Central: PMC7851243].
7. Basmajian HG, Choi PD, Huh K, Sankar WN, Wells L, Arkader A. Radial neck fractures in children: experience from two level-1 trauma centers. *J Pediatr Orthop B*. 2014;23(4):369-74. doi: 10.1097/BPB.0000000000000057. [PubMed: 24811086].
8. Pring ME. Pediatric radial neck fractures: When and how to fix. *J Pediatr Orthop*. 2012;32(Suppl 1):S14-S21. doi: 10.1097/BPO.0b013e31824b251d. [PubMed: 22588098].
9. Anderson TE, Breed AL. A proximal radial metaphyseal fracture presenting as wrist pain. *Orthopedics*. 1982;5(4):425-7. doi: 10.3928/0147-7447-19820401-06. [PubMed: 24822809].
10. Brodeur AE, Silberstein MJ, Graviss ER. Radiology of the pediatric elbow. Boston, MA: G. K. Hall Medical Publishers; 1981.
11. Chapman V, Grottkau B, Albright M, Elaini A, Halpern E, Jaramillo D. MDCT of the elbow in pediatric patients with posttraumatic elbow effusions. *AJR Am J Roentgenol*. 2006;187(3):812-7. doi: 10.2214/AJR.05.0606. [PubMed: 16928950].
12. Degnan AJ, Ho-Fung VM, Nguyen JC, Barrera CA, Lawrence JTR, Kaplan SL. Proximal radius fractures in children: Evaluation of associated elbow fractures. *Pediatr Radiol*. 2019;49(9):1177-84. doi: 10.1007/s00247-019-04445-x. [PubMed: 31177320].
13. Radomisli TE, Rosen AL. Controversies regarding radial neck fractures in children. *Clin Orthop Relat Res*. 1998;(353):30-9. doi: 10.1097/00003086-199808000-00005. [PubMed: 9728157].
14. Peters CL, Scott SM. Compartment syndrome in the forearm following fractures of the radial head or neck in children. *J Bone Joint Surg Am*. 1995;77(7):1070-4. doi: 10.2106/00004623-199507000-00014. [PubMed: 7608230].
15. D'souza S, Vaishya R, Klenerman L. Management of radial neck fractures in children: a retrospective analysis of one hundred patients. *J Pediatr Orthop*. 1993;13(2):232-8. [PubMed: 8459018].
16. Tarallo L, Mugnai R, Fiacchi F, Capra F, Catani F. Management of displaced radial neck fractures in children: percutaneous pinning vs. elastic stable intramedullary nailing. *J Orthop Traumatol*. 2013;14(4):291-7. doi: 10.1007/s10195-013-0252-0. [PubMed: 23843093]. [PubMed Central: PMC3828489].
17. Qiao F, Jiang F. Closed reduction of severely displaced radial neck fractures in children. *BMC Musculoskelet Disord*. 2019;20(1):567. doi: 10.1186/s12891-019-2947-8. [PubMed: 31775704]. [PubMed Central: PMC6882240].
18. Neher CG, Torch MA. New reduction technique for severely displaced pediatric radial neck fractures. *J Pediatr Orthop*. 2003;23(5):626-8. doi: 10.1097/00004694-200309000-00009. [PubMed: 12960625].
19. Kaufman B, Rinott MG, Tanzman M. Closed reduction of fractures of the proximal radius in children. *J Bone Joint Surg Br*. 1989;71(1):66-7. doi: 10.1302/0301-620X.71B1.2915009. [PubMed: 2915009].
20. Rockwood CA. Rockwood and Wilkins' fractures in children. Philadelphia, PA: Lippincott, Williams & Wilkins; 2010.
21. Angelov A. A new method for treatment of the dislocated radial neck fractures in children. Proceedings of the 9th international symposium on topical problems in orthopaedics surgery, Lausanne; 1981 May 15th; Stuttgart, Germany.
22. Futami T, Tsukamoto Y, Itoman M. Percutaneous reduction of displaced radial neck fractures. *J Shoulder Elbow Surg*. 1995;4(3):162-7. doi: 10.1016/s1058-2746(05)80046-1. [PubMed: 7552672].
23. Rodriguez Merchan EC. Displaced fractures of the head and neck of the radius in children: open reduction and temporary transarticular internal fixation. Orthopedics 1991;14(6):697-700. [PubMed: 1866351].
24. Dormans JP. Arthrographically assisted percutaneous manipulation of displaced and angulated radial neck fractures in children: description of a technique for reduction and a new radiographic sign. *J Orthop Tech*. 1994;2(2):77-81.
25. Cha SM, Shin HD, Kim KC, Han SC. Percutaneous reduction and leverage fixation using K-wires in paediatric angulated radial neck fractures. *Int Orthop* .2012;36(4):803-9. doi: 10.1007/s00264-011-1387-3. [PubMed: 22038445]. [PubMed Central: PMC3311808].
26. Rodriguez Merchan EC. Percutaneous reduction of displaced radial neck fractures in children. *J Trauma*. 1994;37(5):812-4. doi: 10.1097/00005373-199411000-00018. [PubMed: 7966481].
27. Steele JA, Graham HK. Angulated radial neck fractures in children. A prospective study of percutaneous reduction. *J Bone Joint Surg Br*. 1992;74(5):760-4. doi: 10.1302/0301-620X.74B5.1527130. [PubMed: 1527130].