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Operative Techniques in
Orthopaedics

Operative Techniques: Closed Intramedullary Pinning (Metaizeau technique) for Displaced Radial Neck Fractures in Children

Charles T. Mehlman, DO, MPH

Radial neck fractures are among the most common pediatric elbow fractures and they account for a disproportionate amount of bad outcomes. Thus displaced radial neck fractures present unique treatment challenges to the orthopaedic surgeons caring for these children. High complication rates associated with closed reduction alone as well as formal open reduction treatment strategies have made indirect reduction and internal fixation the treatment of choice. This article will focus on the dominant operative technique used to treat these injuries: closed intramedullary pinning, otherwise known as the Metaizeau technique.

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Introduction

Radial head fractures and true growth plate fractures of the proximal radius are both quite rare in children as this portion of the bone consistently fails through the periphyseal metaphyseal region otherwise referred to as the radial neck. In contrast to these other fractures, true radial neck fractures are quite common as they are among the top 2-3 most frequent pediatric elbow fractures[1,2] and they are quite clearly associated with a disproportionate amount of bad results.[3,4] Increasing amounts of fracture angulation and translation (aka uncovering of the metaphyseal fracture surface) have most commonly been associated with those bad outcomes (most frequent being significant stiffness).[5] Since closed reduction alone fails over 40% of the time,[5] there has been increasing enthusiasm for internal fixation and stabilization of these fractures following reduction. This article will focus on what has become the most widely used method of indirect reduction and internal fixation of displaced radial neck fractures: closed intramedullary pinning, otherwise commonly known as the Metaizeau technique (Table 1).

Division of Pediatric Orthopaedic Surgery, Cincinnati Children's Hospital Medical Center, University of Cincinnati College of Medicine, Cincinnati, OH.

Address reprint requests to Charles T. Mehlman, DO, MPH, Division of Pediatric Orthopaedic Surgery, Cincinnati Children's Hospital Medical Center, University of Cincinnati College of Medicine, Cincinnati, OH. E-mail: charles.mehlman@cchmc.org

Background Information

The method of closed intramedullary pinning of displaced radial neck fractures described in this article was introduced by the French in 1980.[12] This group, led by Jean Paul Metaizeau, had already enjoyed years of success applying flexible nailing techniques to many other pediatric fractures. They recognized the limitations of existing surgical approaches for radial neck fractures (especially open reduction) and sought improvement. They also appreciated that the prognosis for radial neck fractures was strongly dictated by 2 factors: severity of displacement and associated injuries to the elbow.[12] It must be remembered that there is remarkably little remodeling potential in the proximal radius as it has been shown that by 8 years of age only 10% of the growth of the radius comes from this region.[13] In fairness, there are instances when supplemental reduction is necessary (temporary percutaneous leverage with Kirschner wire) prior to final flexible nail fixation, thus resulting in a Böhler-Metaizeau technique.[14]

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Table 1 The World Votes for Metaizeau (Published Case Series Supportive of the Technique and Country of Origin)

1994 Germany	2006 England	2012 Denmark
1996 Germany	2006 France	2013 Italy
1997 France	2007 Germany	2013 China
1997 Spain	2007 Turkey	2015 Germany
2012 Poland	2009 Germany	2015 India
2001 Italy	2010 Austria	2016 China
2001 Switzerland	2010 Brazil	2017 Turkey
2005 Germany	2010 Turkey	2018 China
		2018 Turkey

Table 3 Currently Listed Indication in Core Pediatric Orthopaedic Trauma Textbooks

Rockwood and Wilkins Fractures in Children (8th ed) 2015	"Operative treatment should be considered when displacement remains over 2 mm, angulation is >45° (age <10) or greater than 30° (age >10)"
Green's Skeletal Trauma (5th ed) 2015	"If there is more than 30°-45° of angulation, more than 4 mm of translation, or restricted motion, operative methods should be considered"

Indications

Indications for surgery are primarily driven by fracture displacement, which includes angulation and translation. There are 2 frequently used displacement-focused classification schemes for pediatric radial neck fractures. In North America the O'Brien[15] classification is most commonly used to categorize radial neck fractures, while European authors typically apply the Judet system[16] (Table 2). Fracture angulation that meets or exceeds 30° (≥O'Brien II or ≥Judet III) is the chief indication for surgery.[6-8] Small series from older literature suggest that translation that meets or exceeds 3-4 mm should also trigger efforts at reduction and stabilization mainly due to concern for cross union.[9,10]

With virtually no exceptions, increasing amounts of fracture angulation are associated with increasing amounts of translation (uncovering of the metaphyseal fracture surface). It must also be acknowledged that a central defect of these classification systems it that they do not account for associated injuries such as elbow dislocation, associated elbow fractures (often 2 or 3 coexist), or nerve injuries. Large contemporary published series have shown that associated injuries occur in 37%-46% of cases.[5,11] These comorbidities are important and clearly influence outcome.

Metaizeau et al have gone on record as saying that excellent clinical results can be expected when treatment produces less than 20° residual angulation.[12] This is congruent with Newman's 1977 definition of a technically satisfactory reduction being less than 20° of angulation and less than 2 mm of translation.[9] Current core pediatric orthopaedic trauma textbooks also suggest fairly aggressive indications for surgery (Table 3).[17,18] These modern radial neck fracture treatment paradigms are a departure from those of the past and time will tell if they lead to commensurate improvements in functional outcome. The largest single center publication to date is an Austrian series that revealed 95% (38/40) excellent results (full range-of-motion and normal function) following the indirect reduction and internal fixation technique of Metaizeau (31% of patient population with associated injuries).[19]

Table 2 Comparison of 2 Most Common Classification Systems

O'Brien (1965)		Judet (1962)	
		I	Undisplaced
I	<30°	II	<30°
II	30-60°	III	30-60°
III	>60°	IV-a	60-80°
		IV-b	>80°
		V	Salter-Harris II

Surgical Technique

A short radially-based incision is fashioned in anticipation of the trajectory of the nail, taking care to protect adjacent branches of the superficial branch of the radial nerve. The distal radius is approached in a physeal-friendly fashion (radial entry hole approximately 1 cm proximal to physis) preferentially using an awl (there is no requirement whatsoever to use a motorized drill). While identifying and protecting adjacent extensor tendons and sensory nerve branches, the entry portal ends up being either between the first and second dorsal compartments or through the floor of the second dorsal compartment (prophylactic DeQuervain release). A stainless steel or titanium flexible nail is chosen based on surgeon preference.

Using the channel bender or similar instrument the end of the nail is then contoured ever so slightly and introduced and advanced to the level of the fracture site. Just like excessive nail diameter, excessive nail contouring will not allow rapid and proper passage of the nail. Nail diameter is chosen based on smallest isthmic (midshaft) intramedullary diameter measurement (full length forearm radiographs are often helpful) remembering to err on the side of smaller rather than bigger. Nail diameters are usually 2.0 mm and smaller, and virtually never 2.5 mm or bigger.

Under fluoroscopic guidance reduction is then either achieved directly by allowing the nail tip to engage the fracture fragment (see Fig. 1) and choosing the rotation moment that improves alignment or by adding the previously mentioned Böhler preliminary reduction technique (see Fig. 2). Certain manual reduction (fracture manipulation) methods may also be utilized at times by the surgeon in order to aid closed reduction. Care must be taken to

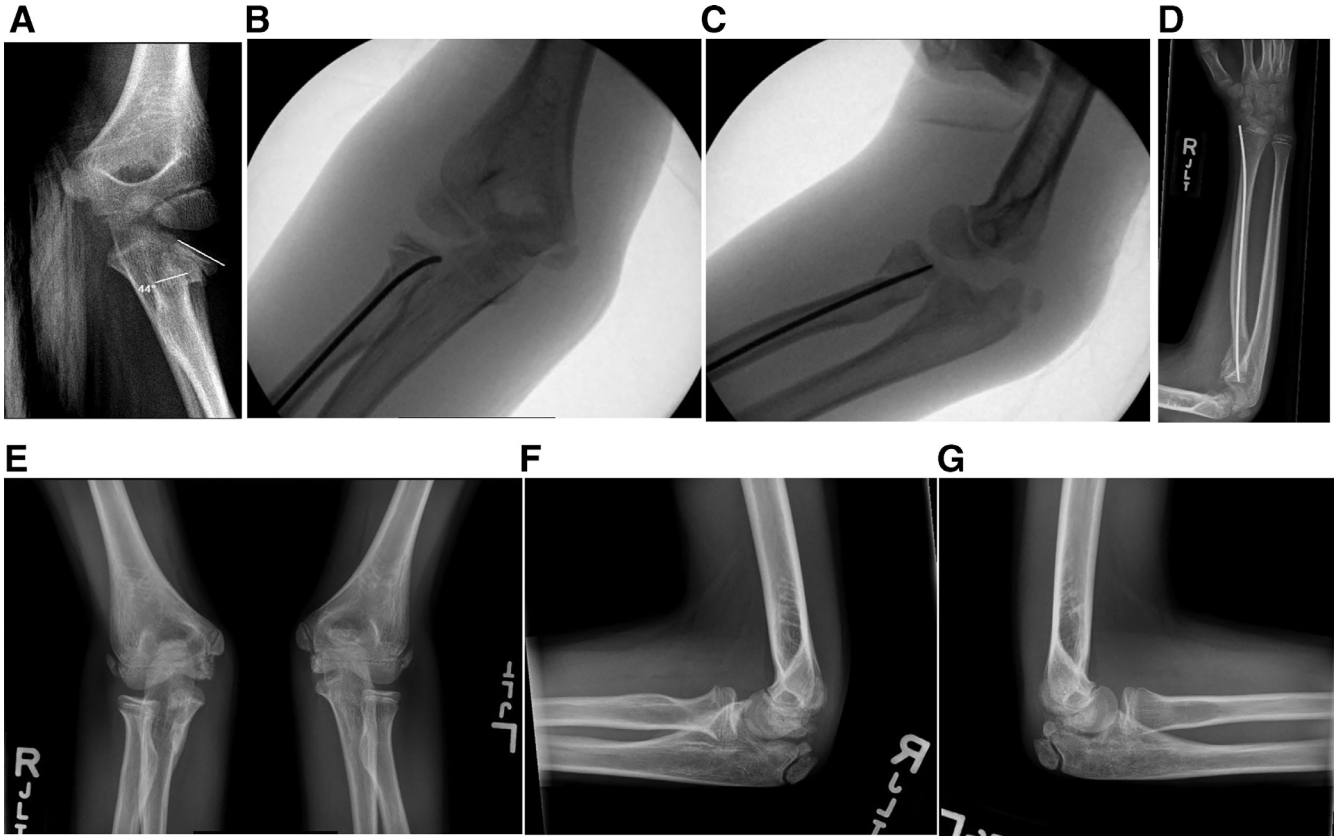

Figure 1 A 9 years 0 month male with right elbow injury treated via Metaizeau technique. (A) Injury AP radiograph showing 44° angulation and approximately 50% translation (metaphyseal uncovering). (B) Fluoroscopic AP image following reduction and fixation with elastic nail. (C) Fluoroscopic lateral image. Care must be taken to not distract the fracture site AND to never allow flexible nail tip to penetrate the joint space. (D) Postoperative AP forearm radiograph showing distal radial entry site. (E) A 2.5 years follow-up radiographs (AP images both elbows). (F) A 2.5 years follow-up lateral radiograph right elbow (mild radial head overgrowth is common with this injury). (G) A 2.5 years follow-up lateral radiograph left elbow.

critically evaluate multiple radiographic images (often including live fluoroscopic images of the elbow going through a range-of-motion) and making certain that the fracture site is not distracted and that the tip of the flexible nail does not penetrate the joint space. The nail is cut at the distal radial entry site such that it is above the tendons but beneath the skin. Using an impactor at this point in the case is a bad idea as it increases the chances of fracture site distraction or joint space penetration. The wound is then closed in a routine fashion and an above elbow splint or cast is applied, again based on surgeon preference. It has been suggested that a period of immobilization not to exceed 2 weeks may be advantageous when treating such radial neck fractures in children.[3]

As a rule of thumb reduction occurs before fixation when treating fracture patients ("R comes before F in the AO dictionary"), but in reality the reduction occurs simultaneously (or certainly in conjunction with) the fixation when using the Metaizeau technique in most displaced radial neck fracture cases. In other words the flexible nail is both a tool for reduction and final fixation as well. One of the most important things to remember regarding closed intramedullary pinning is the need to have patience and let the technique work, which is to say you may reach a point where you have improved fracture alignment but need more. In those situations you must be disciplined enough to completely remove the flexible nail and recontour the tip or switch to a totally new flex nail and finish the case appropriately. This point cannot be overemphasized.

Conclusion

The proximal radius represents a low growth area (as compared to the distal radius) and thus it possesses limited remodeling potential at best. Symptomatic radial neck malunions have been reported along with subsequent corrective osteotomy.[20,21] Early appropriate reduction and stable internal fixation are laudable goals for pediatric radial neck fractures with angulation greater than or equal to 30° or translation (metaphyseal uncovering) of 3 or more mm. Over the course of more than 22 years of pediatric orthopaedic trauma practice the author now considers the Metaizeau

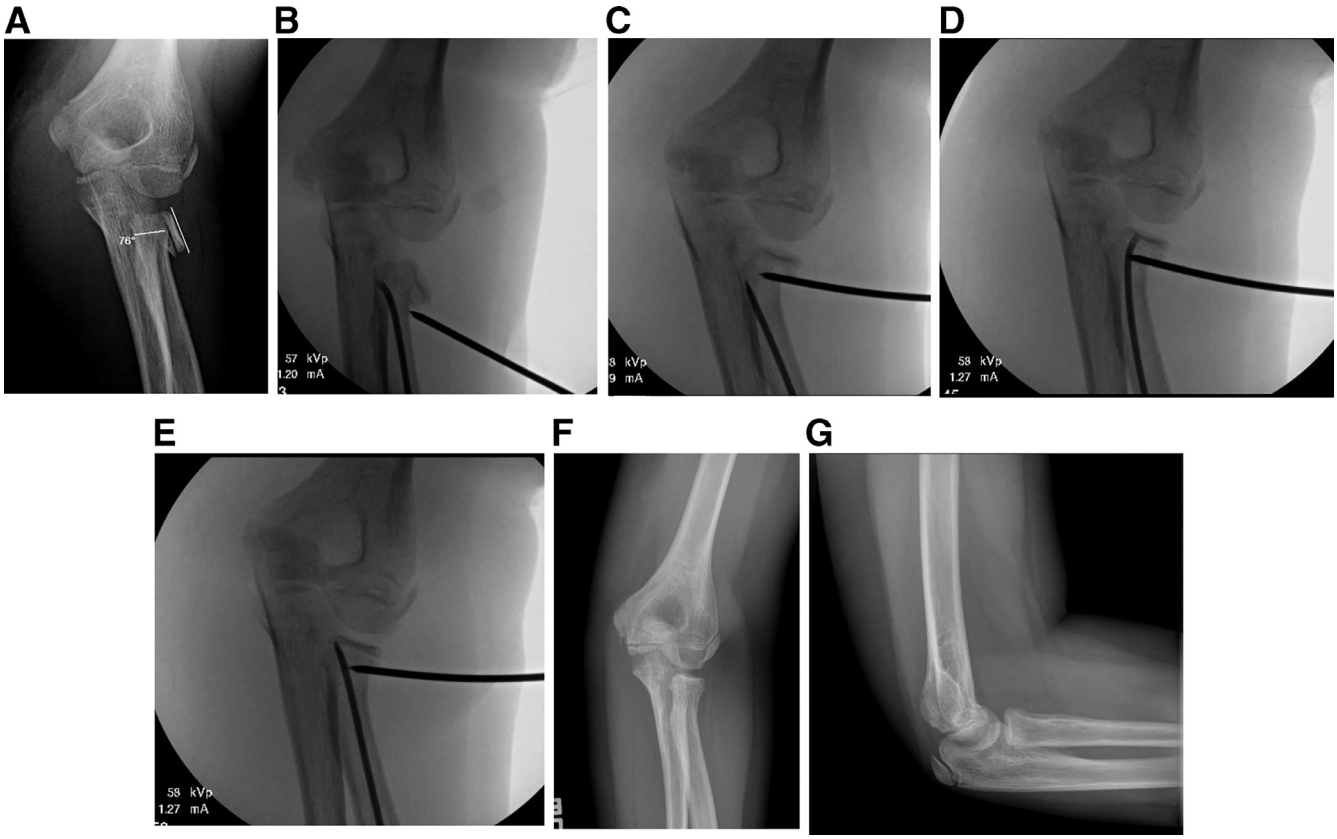

Figure 2 A 8 years 4 month old male with left elbow injury treated via Böhler-Metaizeau technique. (A) AP injury radiograph showing 76° angulation and 100% translation (complete metaphyseal uncovering). (B) Fluoroscopic image showing introduction of percutaneous Kirschner wire (Böhler reduction technique). (C) Kirschner wire has entered fracture site and begun to reduce fracture. (D) Now flexible nail can reach radial head fracture fragment. Note rotation of nail/orientation of contoured tip. (E) Flexible nail has now been rotated to finalize fracture reduction and also provide stable internal fixation. Kirschner wire is subsequently removed (temporary use only). (F) AP radiograph at 6-month follow-up (following implant removal). (G) Lateral radiograph at 6-month follow-up (following implant removal).

(or Böhler-Metaizeau) to be his treatment of choice (having adopted it over a decade ago) for displaced radial neck fractures that merit surgical intervention.

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