Closed reduction and percutaneous pinning in management of epiphyseal injuries of the distal radius in children.

Thesis

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Abstract

Epiphyseal injuries of the distal radius are common in children, and they account for 75% to 84% of pediatric forearm fractures.

Fortunately, most epiphyseal-plate injuries are not associated with any disturbance of growth. After separation of an epiphysis through its epiphyseal plate there may be a slight and transient acceleration of growth, in which case no significant deformity ensues.

Salter-Harris classification is based on the mechanism of injury and the relationship of the fracture line to the growing cells of the epiphyseal plate and is also correlated with the prognosis for growth disturbance. Epiphyseal injuries have also been classified by Poland, Aitken and Magill, and more recently by Ogden.

The goal of treatment is to prevent proximal migration of the distal radial fragment and stabilization of the radioulnar joint.

unStable Displaced fractures of the distal radial physis with median neuropathy and significant volar soft tissue swelling can be managed with closed reduction and percutaneous pinning.

Key words;

Closed reduction and percutaneous pinning in management

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ABBREVIATIONS

- **DRF.** Distal Radial fracture.
- **DRFs.** Distal Radial fractures.
- **TFCC.** Triangular Fibrocartilage Complex.
- **TFC**. Triangular Fibrocartilage.
- **ECR**. Extensor Carpi Radialis.
- **CR.** Closed Reduction.
- **K-Wire**. Kirschner wire.
- **AP.** Antero-Posterior
- **ROM** Range Of Motion
- **No.(in table or figure)** Number of Cases.
- **No.** Number.
- **%.** Percentage.
- **MM.** Millimetre
- ^{0} Degree.

Aim of the work

The aim of this work is to evalaute closed reduction and percutaneous pinning in the management of Metaphyseal fracture of distal radius (Type VIII) according to Ogden's Classification of physeal fracture .

INTRODUCTION

Distal radius fractures are among the most common pediatric injuries, comprising 20% to 35% of all childhood fractures[1-2]. Approximately one third of these fractures involve the distal radial physis[3].

Distal radial physeal fractures account for 25% to 50% of all physeal fractures, making them the most common growth plate injury of long bones[4-5]. Most of these fractures result from low-energy trauma and involve both radial and ulnar epiphyses[6].

Epiphyseal injuries have been classified and reviewed by several authors (Poland, 1898; Salter & Harris, 1963; Aitken, 1965; Ogden, 1981) but perhaps the most widely used classification currently is that of Salter & Harris (1963)[7].

The most commonly use treatment modality is closed reduction and immobilization in plaster. Conservative treatment is gold standard in long term follow up of children with epiphyseal fracture of distal radius [8]. The most important problem in this treatment is to maintain the reduction in a plaster brace; loss of reduction and malunions are frequently seen [9-10].

In order to choose the best treatment modality, it is very important to identify the patients with high risk of reduction loss. Although this subject is not clear in the English literature, translation to either radial or ulnar side more than half of the bone diameter was reported as the most important risk factor[5]. Beside this, volar angulation, non-anatomic reduction (in the first manipulation), associated ulnar fracture at the same level of radius fracture, experience of the surgeon, quality of the plaster and type of anesthesia are common risk factors for the loss of reduction of conservative treatment[11-12].

Epiphyseal fractures of the distal radius in children have high capability of remodelling However loss of rotational capacity of the forearm was reported in 15-29% of the cases after closed treatment [11-13]. Functional loss could be persistent even after prompt remodelling of the angular deformity[14-15].

Fixation with percutaneous Kirschner wire (K-wire) is recommended in patients who carry high risk of reduction loss after closed treatment in order to prevent forearm rotational loss[16-17-18].

In this study pediatric patients who had epiphyseal distal radius fracture with high risk of reduction loss We aimed to determine the effect of percutaneous K-wire fixation after the first reduction maneuver in the patients who had risk of reduction loss in the plaster brace.

Distal radial Physeal Anatomy:

The skeleton of a 10-week-old fetus is 100% cartilage. At birth, bone mineralization is approximately 85% of adult composition, but a large portion of cartilage remains to allow for growth. Growth in long bones occurs through endochondral ossification, the process by which a cartilage progenitor is converted to bone [19].

Developmentally, the primary ossification centers of the radius and ulna appear during the eighth week of gestation. The secondary ossification center of the distal radial epiphysis typically becomes radiographically apparent by the first year of life; rarely, there may be a separate secondary ossification center at the tip of the radial styloid. The contour of the radial styloid progressively elongates with advancing skeletal maturity. The distal ulnar epiphysis ossifies at approximately the age of 6 years in children and often develops from two distinct centers of secondary ossification. the ulnar styloid appears with the adolescent growth spurt. Knowledge of these patterns of epiphyseal development may assist in the distinction between subtle physeal injuries and developmental norms. Furthermore, comparison radiographs of the contralateral wrist may be helpful in these situations. The distal radial physis contributes approximately80% of the longitudinal growth of forearm and 40% of the growth of the upper extremity. For this reason, fractures of the distal radius have tremendous remodeling potential.[20–21–22].(Fig.1).

The date of the appearance of the ossification centers of the radius and ulna and their maturation generally occurs earlier in girls than in boys.[23] It is established that at birth, the metaphysis of the radius and ulna are normally present. They appear during the first five months of prenatal development. On average, the ulnar physis closes at age 16 in girls and age 17 in boys, whereas the radial physis closes on average 6 months later than the ulnar physis. [Table 1].[24–25]

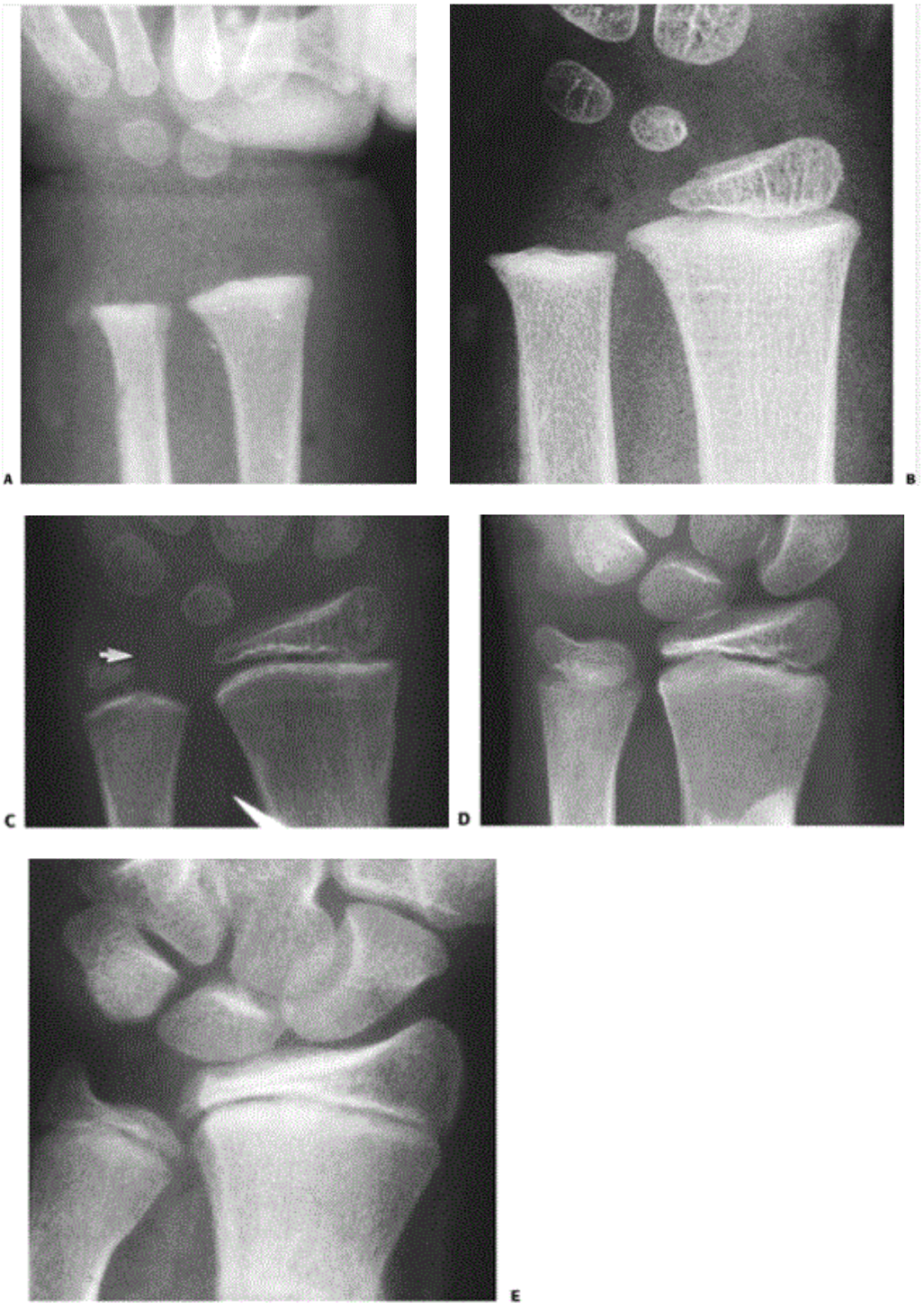

FIG.1: Ossification of the distal radius. A. Preossification distal radius with transverse ossification in a 15-month-old boy. B. The triangular secondary ossification center of the distal radius in a 2-year-old girl. C. The initial ossification center of the styloid in this 7-year-old girl progresses radially (arrow). D. Extension of the ulnar ossification center into the styloid process of an 11-year-old. E. The styloid is fully ossified and the epiphyses have capped their relative metaphyses in this 13-year-old boy. (Rockwood CA Jr. Wilkins KE, Beaty JH, eds. Rockwood and Greens Fractures in Children, 4th ed, vol. 3. Philadelphia: Lippincott-Raven, 2010:515.)

Table 1: Appearance of Ossification Centers in Their Normal Sequence and Dates of complete Ossification and Fusion According to w. Greulieh and S.I.Pyle(1984) :

	Sex	*First Appearance (mos.)*	*Adult Status (Yrs.)*
1-Capitate	Male	Birth-3	17-18
	Female	Birth-3	15-16
2-Hamate	Male	3	14-15
	Female	3	12-13
3-Distal epiphyseal	Male	12-15	18-19
of radius	Female	9-15	17-18
4-Ttiquetrum	Male	24-36	15-16
	Female	18-25	15-16
5-lanute	Male	32-42	
	Female	30-36	
6-Trapezium	Male	3 1/2-5 yrs	
	Female	36-50	
7-Trapezoid	Male	5-6 yrs	
	Female	3 1/2-4 yrs ,2 mo	
8-Scaphoid	Male	5-6 yrs , 4 mo	
	Female	3 1/2-4 yrs , 4 mo	
9-Distal epiphysis	Male	5 yrs, 3 mos-6-10	
of ulna	Female	5 1/2 yrs -6 1/4 yrs	
10-Pisiform	Male		17-18
	Female		16-17

All long bones of a growing child consist of an epiphysis, physis, and metaphysis at each end separated by the diaphysis. Physis is a Greek word (phyein) which means nature, or to generate. In English it means something that grows or becomes. English medical dictionaries designate the physis as the segment of bone responsible for growth in length of the bone. The diaphysis is the initial and primary center of ossification (PCO). The physis is a complex structure, discoidal in form and often referred to as a “plate,” i.e., the epiphyseal growth plate.[26]

The epiphysis is the secondary center of ossification located at the end of the long bone. (Fig.2) The cartilage, which reside between distal ends of long bone (epiphysis) and ossification centers in the diaphysis, ultimately comprise the epiphyseal growth plate or the physis, which is specialized tissue layers oriented perpendicular to the longitudinal axis of the bone and are usually subjected to both the compressive force of muscle contraction as well as to the forces of weight bearing. Damage to the physis is referred to as an epiphyseal growth plate injury or more commonly a physeal injury.[23]

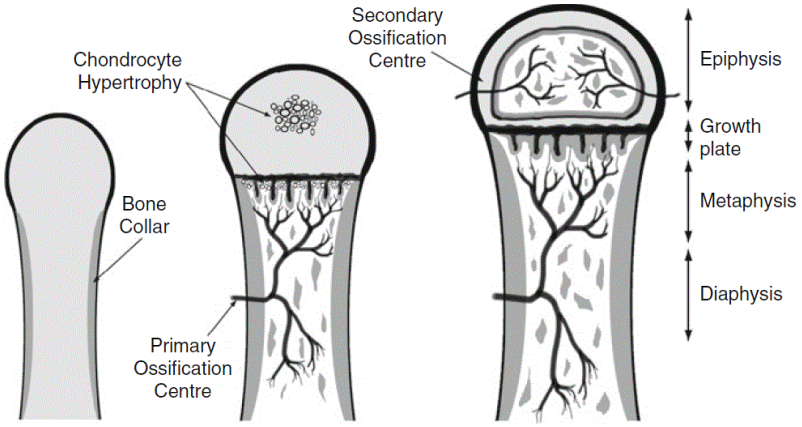

Fig. 2.1 Schematic representation of endochondral bone formation. Skeletal maturity is mainly assessed by the degree of development and ossification of the secondary ossification centers in the epiphysis

The radius is connected to the ulna via the proximal radioulnar articulation, the interosseous membrane, and the distal radioulnar articulation (Fig:3). The distal and proximal radioulnar joints are interdependent for stability. With pronation and supination, movement occurs at each of these joints. Bado noted that with pronation, the radius "shortens" and, with supination, it "lengthens" relative to the ulna.[27] This

interdependence may be the reason for late dislocation of the radial head in children who have had significant shortening of the ulna after an injury to its distal end.[28]

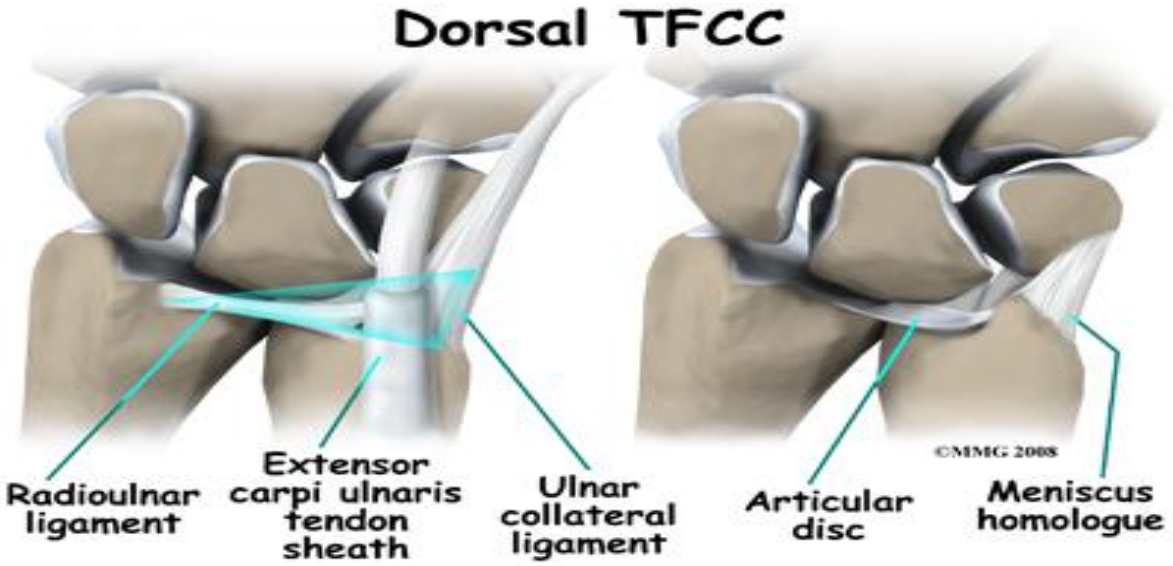

Fig.3: Anatomy of the Distal Radius articulation.

The TFCC refers to a convergence of structures on the ulnar side of the wrist . First described by Palmer and Werner, these structures include the triangular fibrocartilage, the dorsal and volar radioulnar ligaments, the meniscal homolog, the ulnolunate and ulnotriquetral ligaments, and the subsheath of the extensor carpi ulnaris (ECU) tendon [29].

The triangular fibrocartilage complex (TFCC) is the primary stabilizer of the ulnocarpal and radioulnar articulations (Fig.4). It extends from the sigmoid notch of the radius across the DRUJ and inserts into the base of the ulnar styloid. It also extends distally as the ulnolunate, ulnotriquetral, and ulnar collateral ligaments and inserts into the ulnar carpus and base of the fifth metacarpal.[30]

Functionally the TFCC provides a smooth articular surface between the radius and ulna, transmits and absorbs axial loads across the ulnocarpal articulation, and contributes stability to the ulnar wrist and DRUJ. Previous studies have demonstrated that approximately 20% of the axial load is transmitted across the ulnocarpal joint in wrists with neutral ulnar variance [30]. Small changes in ulnar variance may result in significant alterations in axial loads borne by the TFCC.