Summary

Fractures of the proximal radius in children account for about 1% of all children fractures, represent 5 to 10 % of all elbow fractures and accounts for 5% of all fractures involving the growth plates, average age is 10 years (4 to 16 years) with no difference between boys and girls and approximately 50% involve the head and 50% the neck.

Although it is a rare fracture, it is important to be assessed accurately in every child with elbow trauma. This fracture must be assessed and overviewed as an epiphyseal growth plate fracture that may be extra-articular (metaphyseal), intra-articular (epiphyseal) or combined.

The epiphyseal secondary center of ossification of the radial head epiphysis begins to ossify at about the age of 4 years in females and a year later in males. This physis closes at age 12–14 years in females and 14–15 years in males. The percentage of growth provided by the proximal radial physis gradually diminishes throughout growth: 50% at birth, 35% at mid- childhood and 20% at maturity.

The blood supply to the epiphysis is derived from the recurrent radial and superior interosseous arteries, which anastomose with the periosteal network of arterioles from the supinator.

The Mechanism of injury of the proximal radial physis is one of three injury mechanisms: Valgus force to the extended forearm; shearing force during elbow dislocation or reduction; or fracture dislocation such as Monteggia variant.

Proximal Radial Epiphysis injury was classified by:

1- **Jeffrey 1950** based on the mechanism of injury.

2- **O'Brien 1965** based on the degree of angulation into three types**.**

3- **Wilkins 1991** based on the mechanism of injury and displacement**.**

4- **Peterson**, **1994** based on sequential order both ***Anatomically*** from least to most

sever physeal involvement and ***Prognostically,*** (based on need for surgery, both immediate and late and with occurrence of complications), from least to most common.

Classification based on degree of angulations does not determine the amount of physeal damage, and is subject to the plane of the roentgenograph projection. In addition, the degree of angulation in a fresh fracture may change at any time before or after the original roentgenograph. These specific numbers of degree are often given with no regard to positioning the forearm rotation to capture the greatest degree of angulation, or to the age of the patient.

Diagnosis:

Clinically there is swelling and pain with limitation of movement. Pain is more with rotation than with flexion and extension and it is localized over the radial head or neck and may be referred to the wrist.

Standard antero-posterior, lateral, supination-pronation, perpendicular, radio-capitellar (Greenspan) views may be used to achieve accurate radiological diagnosis.

The key to diagnosis of fracture of the unossified head is to perform a thorough clinical examination, on x-ray, the smoothness of the metaphyseal margin may be lost. ***Ultrasonography***, ***Arthrography*** or ***magnetic resonance imaging*** (MRI) can be used.

Treatment:

Treatment considerations of proximal radial physeal fractures are based more on the amount of fragment displacement and the precise physeal damage, than on the degree of radial head angulation, or than by the fear of ischemic necrosis.

Angulation is defined by the angle between a line perpendicular to the articular surface of the radial head and a line down the central radial shaft drawn on the antero-posterior radiograph. **Translation** is defined as the width of uncovered radial metaphysis divided by the total metaphyseal width, multiplied by 100.

The methods of treatment for radial head injury include:

1. Simple immobilization with no manipulation is used in fractures with angulation of 30 degrees or less, or translocation of less than four mm in the form of a collar and cuff, a posterior splint, or even a light long-arm cast for 2-3 weeks.

2. Manipulative closed reduction under general anesthesia is indicated if angulation is between 30-60 degrees or more with retention of 50% of appositioin of the fragments or more. Methods include:

A-Patterson's Manipulative Technique.

B-Flexion-pronation (Israeli) reduction technique.

C- Reduction technique by Neher and Torch, 2003.

3. Percutaneous pin reduction with an image intensifier used in reducing moderately to severely displaced fractures.

4. Intramedullary pin reduction can be used in reducing moderately to severely displaced fractures using a K-wire, Nancy nail or Ilizarov wire.

5. Open reduction with or without internal fixation is associated with complications not usually seen with closed reduction. So, Open reduction is reserved for fractures where results of the best reduction achieved by closed reduction and functional problems due to deformity may outweigh the risks of open reduction. Whenever possible, internal fixation should be avoided.

Indications include:

1- Complete Displacement.

2- Residual angulations of more than 45-degree and/or translation more than 4 mm.

3- Irreducible.

4- Displaced proximal radial fractures that involve both physeal and articular cartilage, as with all physeal and intraarticular fractures, anatomic reduction (open if necessary) is mandatory.

Technique:

A posterolateral Kocher approach is optimal. Usually, the head fragment is stable after being reduced. If it is not, fixation is achieved by one of the following methods:

1. Transarticular pinning (Transcapitellar Pins) is hotly debated as it breaks even if a long arm cast supports it. Even if the pin does not break, the slight motion of the pin causes erosion of the joint surface and even fragmentation of the head.
2. Retrograde pinning is difficult to be accomplished without further displacing the epiphyseal fragment.
3. Oblique Pin Fixation: placement of the pin obliquely across the fracture site into the head either in a proximal to distal direction or the preferred distal to proximal.
4. Two crossed Kirschner wires to prevent displacement of the fragments during healing and avoid crossing the epiphyseal plate.
5. New technique by Bhargava, 1999: Displaced radial head can be openly reduced and fixed using three 'K' wires and cement.
6. Biodegradable pins
7. Fibrin adhesive system

6. Excision of either the entire head or the small head fragment:

Excision of the radial head in any child with significant growth remaining (three years or more) should be avoided as it results in serious complications.

Peterson classification and opinions:

Peterson type 1: may be immobilized in collar and cuff, a posterior splint, or even a light long-arm cast for 2-3 weeks.

Peterson type 2 or 3: If minimally displaced or can be manually reduced, immobilization for 3–4 weeks will suffice. When closed reduction is incomplete or unstable, open reduction is indicated.

Peterson type 4: This usually requires open reduction and internal fixation, so as to achieve precise anatomic reduction to restore articular congruity and prevent displacement of the fragments during healing.

Peterson type 5: if minimally displaced treated closed with elbow in extension. Displaced fractures are reduced and fixed from epiphysis to epiphysis.

Peterson type 6: Regardless of how little physis is lost, the remaining physis always stops growing. Late reconstructive surgery is usually necessary.

Complications: Incidence of poor results varies from 15% to 33% and 50% in severely displaced fractures.

Loss of joint motion is the most common complication. Rotation is primarily affected. It should be accepted during the growing years even if significant.

Premature physeal closure: result from most proximal radial physeal fractures. It may cause mild degrees of cubitus valgus, but does not result in radial shortening.

Avascular necrosis of proximal radial epiphysis is uncommon (10% to 20%) even when the head is completely separated.

Treatment recommended is continued active motion of the elbow while waiting remodeling, with radial head resection at skeletal maturity reserved for painful elbows.

Malunion results in erosion on the articular surfaces, with subsequent degenerative joint disease due to incongruity the joint.

Nonunion of the radial neck is a rare complication. Treatment protocol is to observe the patients with limited symptoms, a functional range of motion, and acceptable radial-capitellar radiographic alignment. Open reduction is performed for displaced nonunions with radial head-capitellar malalignment, limited range of motion, and restricting pain.

Radio-ulnar synostosis is the most serious complication. Achieving a position of optimal forearm rotation, by osteotomy if necessary, may be the treatment of choice.

Neurological injuries and volar forearm ***compartment syndrome***