Pediatric fractures: Not just small bones.

Poster No.: C-1393
Congress: ECR 2013
Type: Educational Exhibit
Authors: J. Sánchez Monforte, I. Millán Arredondo, D. Llanos; Madrid/ES
Keywords: Paediatric, Trauma, Emergency, Conventional radiography, Education, Education and training
DOI: 10.1594/ecr2013/C-1393

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

In this educational exhibit we explain the peculiarities of pediatric bone and review the most common fractures in children, with a special emphasis on those that are often overlooked by non-pediatric radiologists, orthopedic surgeons and pediatricians.
Background

Pediatric bones differ from adult bones mainly because of:

- A greater deformability before breaking.
- The presence of growth cartilages.

That's why many of the fractures that affect pediatric patients are only seen on this group of patients. Some of them may be subtle on the X-Ray exams and can be overlooked by practitioners unaware of their radiologic signs. Other fractures are conspicuous, but have specific treatment requirements.
To achieve a right diagnosis, the X-ray exams must meet a minimum of quality requirements. Two orthogonal projections are mandatory when studying long bones, and if there are doubts about the position of the ossification nuclei or bone morphology, it's useful to obtain images of the healthy limb to allow comparison.

We classify fractures in three groups: fractures due to the flexible nature of the bones, fractures involving the growth plate and a third group including some other miscellaneous fractures.

1.- The higher deformability of the infantile bone is responsible of the existence of different kinds of incomplete fractures, where the bone cortex is not completely disrupted. Some of them might be subtle on plain films, and a "classic" fracture line may be missing.

- **Bending fractures** *(Fig. 1 on page 7)*. The bone appears bowed without cortical disruption.

- **Torus or buckle fractures** *(Fig. 2 on page 7)* appear as a buckling of the bone without cortical disruption. They are very common on distal radius, as the result of an axial compression injury.

- **Greenstick fracture** *(Fig. 3 on page 8)*. One cortex is disrupted while the other is bended without disruption.

These fractures are managed with orthopedic treatment. Greenstick fractures may need to be turned to a complete fracture (under anesthesia!) to allow a good alignment before immobilization.

2.- Fractures involving **physeal cartilages** can affect the normal growth of the bone. They can result in partial or total epiphysiodesis, and therefore originate progressive angular deformities or dismetry to the contralateral limb. **Salter-Harris** classification *(Fig. 4 on page 9)* divides physeal fractures in five groups:

- **I** *(Fig. 5 on page 10)*: Fracture through the physeal cartilage, without bone involvement. The epiphysis can appear displaced relative to metaphysis.
- II (Fig. 6 on page 10): Fracture through the physis that extends into the metaphysis.

- III (Fig. 7 on page 11): Fracture extends from the physis into the epiphysis.

- IV (Fig. 8 on page 12; Fig. 9 on page 13): Fracture extends from the physis into the metaphysis and epiphysis.

- V (Fig. 10 on page 14; Fig. 11 on page 15): Crushing of the growth plate.

The most common Salter-Harris fracture is type II. The higher the number, the worse the prognosis.

Type I and II are managed with orthopedic treatment. Reduction may be necessary if the epiphysis is dislocated.

Type III and IV usually require surgery.

Type V may require surgery to prevent excessive angulation or dismetry. In older children with a lower growth potential, sometimes is more practical to perform a surgical epiphysiodesis of the healthy limb to avoid dismetry.

3.- Under the category "other fractures" we include some fractures with special features that worth a specific explanation.

- Supracondylar fracture (Fig. 12 on page 16; Fig. 13 on page 17) is the most common elbow fracture in the pediatric population. Even with proper radiographs the diagnosis can be difficult, as they may not show a fracture. There are two indirect signs of supracondylar fracture very useful in these cases. A line drawn along the anterior surface of the humerus on the lateral radiography (called "anterior humeral line") should intersect the middle third of the capitellum. If there is displacement of the capitellum because of a fracture, the line will no longer pass through the middle third. The posterior fatpad of the elbow is usually hidden within the olecranon fossa. If it becomes visible on the lateral radiograph, it's a certain sign of articular effusion, and is nearly pathognomonic of hemarthros produced by an intra-articular fracture if there has been a traumatism. Supracondylar fractures need reduction and surgical fixation when displaced. If there is not displacement, they are managed with orthopedic treatment.

- Slipped femoral epiphysis (Fig. 14 on page 18; Fig. 15 on page 19; Fig. 16 on page 20): It's a Salter-Harris type I fracture involving the proximal physis of the femur. As the hip is a joint due to bear a lot of weight, the fracture will be progressively displaced along time. If the vessels that reach the femoral head through the femoral neck get disrupted, presently it will appear avascular necrosis. This condition usually affects
obese adolescents and it's not uncommon to be bilateral. The fracture can't be seen on the radiography, so you have to look for early signs of epiphyseal displacement. The Klein's line is drawn along the superior cortex of the femoral neck. In normal conditions, it should intersect the femoral head. If there's displacement, it won't pass through the femoral head. Slipped femoral epiphysis needs surgical treatment as soon as possible. Because of the high incidence of bilateral affectation, many authors advocate surgical fixation of both hips.

-Metaphyseal fracture (Bucket handle fracture) (Fig. 17 on page 21): A metaphyseal fracture is a series of microfractures across the metaphysis; the fracture line is oriented essentially parallel to the physis, although it may not travel the entire width of the bone. It's virtually pathognomonic of child abuse.

-Toddler fracture (Fig. 18 on page 22): Toddler's fractures are oblique non-displaced fractures caused by low-energy torsional forces applied to the very porous bone of infants and young children. The tibial diaphysis is the most common affected site, but may involve other bones. Even if the radiograph doesn't show a fracture, orthopedic treatment should be performed. If findings on these radiographs are negative and the child is still limping, further evaluation should be undertaken to rule out osteomyelitis and malignancy.
Fig. 1: Bending of the distal ulna and radius.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 2: Subtle buckling of the distal metaphysis of the radius.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 3: Greenstick fracture of the radius.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
**Fig. 4:** Salter Harris fracture classification

© Joaquín Sánchez Monforte

**Fig. 5:** Salter Harris type I fracture. Fracture through the physeal plate and displacement of the epiphysis.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 6: Salter Harris type II. Fracture of the physis of distal tibia that extends into metaphysis.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 7: Salter Harris type III. Fracture of the physis of distal tibia that extends into epiphysis.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 8: Salter Harris type IV. Fracture of the distal tibia involving metaphysis, growth plate and epiphysis. Note also the type II fracture of the distal fibula.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 9: CT of the same patient in Fig. 8

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 10: Salter-Harris type V fracture of the distal phalanx of the 5th finger. The physeal cartilage is almost completely crushed and can't be seen.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 11: MR of patient in Fig. 10. T2W GE

© Radiología, Hospital Clínico San Carlos - Madrid/ES
**Fig. 12:** Normal anterior humeral line. There's no posterior fatpad.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 13: Supracondylar fracture of the distal humerus. Note displacement of capitellum related to anterior humeral line. Posterior fatpad can be seen and the anterior fatpad is displaced.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
**Fig. 14:** Normal Klein’s lines.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 15: Slipped femoral epiphysis. The right proximal femoral epiphysis is displaced due to a fracture through the physis.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 16: Radiograph of the same patient in Fig. 15. The slipped femoral epiphysis wasn’t noticed the first time, and one week later the patient returned like this.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Fig. 17: Metaphyseal fractures on an abused child. Note the fractures of the proximal and distal metaphysis of the left femur.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
**Fig. 18:** Toddler's fracture of the tibia.

© Radiología, Hospital Clínico San Carlos - Madrid/ES
Conclusion

Almost every radiology resident or consultant radiologist can be asked about an exam of a child with a potential bone fracture.

This poster is a simple while comprehensive guide to be ready for this situation when on call or on regular practice.
References


