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Joint Pain in Children, Part III: Types of Fractures and Avulsions

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One of the common causes of joint pain in children is trauma. It may be a single incident or due to overuse. Developing bones and joints respond to injuries differently than fully developed bones and joints. There is a greater remodeling potential, for growing bones will change the effect on treatment and management of an injury. Since remodeling is very easy for growing bones, the reduction of a fracture and positioning of the fracture site that would be unacceptable for adults may often be acceptable positioning for children, often sparing children the rigors and dangers of surgery.

In addition, developing joints are usually more likely to repair damage to their articular cartilage than mature or deteriorating joints. Thus, the prognosis of fractures involving joints is more favorable in children than adults. Growing joint capsules, ligaments, and muscles are more tolerant to prolonged immobilization than are deteriorating joint capsules, ligaments and muscles. Therefore, the need for prolonged immobilization is less likely to contraindicate closed methods of treatment in children than it is in adults.

Epiphyseal fractures of long bones can interfere with the growth of the injured bone. These fractures occur through the zone of proliferation. These epiphyseal fractures have been categorized into five groups, each of which present diagnostic and prognostic peculiarities.

Figure 1: The Salter-Harris Classification of epiphyseal fractures.

A) Normal	B) Salter I	C) Salter II
D) Salter III	E) Salter IV	F) Salter V

The crushed growth plate is usually not radiographically present.

Salter I fractures are transverse fractures of the growth plate without injury to the bony metaphysis or epiphysis. When these fractures are undisplaced, they are not radiologically evident at the time of injury. Tenderness over the level of the growth plate of a long bone and a normal x-ray imply a Salter I fracture until developments prove otherwise. Repeat x-rays after two weeks will show bone resorption and calcium deposition characteristic of fracture healing, if the Salter I fracture has occurred. Salter I fracture must be reduced and immobilized until radiologic and clinical union are evident: after two months at the least. True Salter I fractures rarely interfere with growth.

Salter II fractures are transverse fractures of the growth plate which have split obliquely into the bony metaphysis. This fracture and the Salter I fracture are by far the most common of the epiphyseal fractures. Treatment and prognosis are identical to those of the Salter I fracture.

Salter III fractures are transverse fractures of the growth plate which have split obliquely into the bony epiphysis. Why this fracture occurs and not the Salter I or II fracture is not known, but its occurrence may reflect subtle differences in direction of injuring forces. This fracture is more likely to lead to growth arrest than are the Salter I and Salter II fractures. Reduction must be anatomic. The injury should be managed by a good orthopaedist.

Salter IV fractures extend axially into the bony metaphysis and into the bony epiphysis. The fracture may appear to extend axially from the bony epiphysis to the bony metaphysis directly through the growth plate, or it may appear to extend axially through the bony epiphysis, transversely across part of the growth plate, then axially into the bony metaphysis. However it appears, the danger of growth arrest is very great. Reduction must be anatomic. The injury must be managed by a good orthopaedist.

Salter V fractures crush the growth plate. While this injury can accompany crush fractures of the epiphysis, the typical injury stands alone. Its initial clinical characteristics are indistinguishable from those of the undisplaced Salter I fracture, which are initial radiologic invisibility, initial tenderness at the region of the growth plate, and eventual appearance of radiologic signs of bone healing (within 2-3 weeks). The distinction between the Salter I and V occurs months later when it becomes evident that an injured bone is no longer growing and that its bony epiphysis may have fused with its bony metaphysis. When this tragedy emerges, the clinician recognizes the injury to have been a Salter V fracture. Even if the injury could have been recognized on the first day, very little could have been done to change the outcome.

The prognosis of epiphyseal fractures differs not only among the types, but also among the locations. Except following Salter V injuries, epiphyseal fractures in the upper extremity are rarely followed by growth failure. In the lower extremity, any epiphyseal fracture can be followed by growth failure and the Salter III and IV fractures carry a very guarded prognosis. The Salter V fracture, of course, results in a cessation of growth.

A good example of a special Salter I fracture of the epiphysis is the slipped femoral capital epiphysis. This injury occurs during the adolescent rapid growth period between 10-15 years of age and is the result of a slipping of the neck on the femoral head as the head remains in the acetabulum. The diagnosis of a slipped femoral capital femoral epiphysis often requires an astute clinician, as 50% of the cases do not have an apparent history of trauma.

Clinical symptoms are a limp accompanied by hip pain referred to the knee. About 50% of patients have a history of significant injury antecedent to the discovery of the injury. In such cases, it may be the result of trauma and represents an actual traumatic fracture through the growth plate. In some cases, it occurs in a normal child without a history of injury. In many cases the exact etiology of the slipped epiphysis is unknown. Many of the children with slipped femoral capital epiphysis tend to be overweight and the slipped epiphysis is associated with Frohlick's type of obesity. Frohlick's syndrome is characterized by marked obesity and hypodevelopment of the gonads, and is considered a form of hypopituitarism.

Radiographic findings include a widened, ill-defined growth plate with slight metaphyseal deossification. The height of the epiphysis on the slipped side will be less than on the normal side. Normally, the head of the femur and the medial third of the metaphysis of the femur will sit within the acetabulum. When the slipped epiphysis occurs, the medial third of the metaphysis will migrate laterally away from the acetabulum. As the femoral head is displaced medially and inferiorly, the lower margin of the epiphysis becomes beak-shaped.

A very helpful sign enabling detection of a slipped capital femoral epiphysis is the use of Klein's line. This line is used on the AP projection and represents a line drawn along the superior lateral cortex of the femoral neck, which extends through a small portion of the lateral margin of the femoral epiphysis normally. In slipped epiphysis, the femoral epiphysis on the affected side will lie more medial to this line, so that no intersection with the epiphysis occurs at all.

The usual treatment for slipped femoral capital epiphysis is to prevent further slip of fixation of the femoral epiphysis in relation to the femoral neck by mechanical fixation in the form of a threaded pin. Multiple pins are used to obtain several points of fixation. The pins are usually removed after growth plate fusion has occurred.

Another common injury occurring in children are avulsion injuries. Abrupt contraction of a muscle against strong resistance may cause an avulsion fracture of one of its attachments. These avulsions are likely to occur during adolescence, when the attachments are still ununited with the epiphysis.

Diagram from Orthopaedics in Primary Care by Ramamurti.

Abrupt resisted hip flexion, as may occur when a kick is blocked, may cause one of the following avulsions: rectus femoris may avulse its origin from the anteroinferior iliac spine; sartorius may avulse its origin from the anterosuperior spine; iliopsoas may avulse its insertion from the lesser femoral trochanter.

Abrupt opposed hip extension, as may occur during an effort to rise with a weight, or during the splits, may avulse the origin of the semimembranosus, semitendinosus, and/or long head of the biceps femoris from the ischial tuberosity.

Abrupt opposed hip abduction, as may accompany a fall, can avulse the insertion of the gluteus medius and minimus from the greater femoral trochanter.

Abrupt opposed hip adduction or hip extension, as may occur during a fall or the splits, can avulse the origins of the adductor group from the inferior ischiopubic ramus and ischial tuberosity.

If managed correctly, most of these avulsion injuries will repair with no major residual disability. When x-rays demonstrate avulsion fractures with little separation, the patient may be instructed to avoid weightbearing and intentional contraction of the muscle for six weeks. If at the time callus information is adequate by x-ray, active range of motion and muscle strengthening exercise and progressive weightbearing may be started. On the other hand, when x-rays demonstrate avulsion fracture with wide separation, the patient must be referred to an orthopaedist who can immobilize the patient with a spica test or repair the avulsion by open reduction and internal fixation. The healing time will vary with the severity of the injury; restriction of activity for a two months or more is often necessary following the more severe injuries.

References

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