



POSNA

The Core Curriculum

Fractures of the physis

Objectives

1. Describe the layers of the growth plate, and describe the mechanical strength of each layer.
2. Describe the periphery of the physis, and the role these structures play in mechanical stability of the physis
3. Describe the Salter-Harris classification of growth plate injury
4. Discuss the variations noted in actual fracture patterns from the idealized classification and the reasons underlying such variation
5. Describe factors which may contribute to premature physeal arrest
6. Discuss strategies which can minimize the incidence of subsequent physeal arrest following physeal fracture

Discussion

The growth plate is a common site of fracture, accounting for 15-20% of all childhood fractures. The distal radius is the physis most frequently fractured. Strength of the growth plate has primarily been studied in rats, noting that the hypertrophic zone was weakest to tension, with an decrease in strength at the onset of sexual maturation. In the bovine growth plate, with application of pure tension, shear, and compression forces; tension resulted in failure in the proliferative zone, shear at the junction between the proliferative and hypertrophic zones, and compression at the level of the calcified cartilage bars. In such studies, the contribution of the perichondrial ring of LaCroix and node of Ranvier are often not studied, and the protective effect of these structures is not considered. Especially protective is the ring of LaCroix with its extension of metaphyseal bone protecting the periphery of the physis, although this protection becomes less effective in adolescence. In addition, actual injuring forces are seldom pure tension, shear, or compression; thus differing parts of the growth plate can be subject to differing forces. Finally, the undulation of the plate (more so in the distal femur, less in the distal radius, etc) and its mamillary processes provide some resistance to shear. In actual specimens of distal tibial physeal fractures, the fracture line meandered through different zones of the physis.

Nonetheless, the Salter-Harris classification has been used for 40 years as the primary classification of growth plate injuries, and full knowledge of this classification is essential. Type I injuries are separations of the growth plate without bony fracture. Type II fractures include a variable amount of metaphyseal bone with the epiphyseal fragment, the fracture line is the same as Type I except where it extends into the metaphysis. Type III injuries include a physeal component as in group I, with an extension of the fracture line through the epiphysis into the joint. Type IV injuries are characterized by the fracture line extending through the epiphysis, physis, and metaphysis. These

injuries will result in premature arrest if not anatomically reduced. Type V injuries are crush injuries to the plate. Peterson has questioned the existence of an isolated Type V fracture.

Fractures of the distal femoral physes and distal tibial physes, relatively common injuries where weightbearing forces play a large role in injury, type II fractures can be followed by premature physal arrest. This is undoubtedly secondary to the factors enumerated above, and underscores the need for gentleness when attempting reduction of such injuries. If a segment of physis remains with the distal fragment; and repeated attempts at closed reduction without muscular relaxation are made, it is not difficult to imagine that further injury to the physis can occur iatrogenically.

Principles of minimizing complications after physal injuries thus include gentleness of reduction, and anatomic reduction of injuries (Type IV in particular) which will result in growth arrest if not anatomically reduced. Type III fractures not anatomically reduced will result in joint incongruity and deformity if not anatomically reduced but physal growth will generally continue (lateral humeral condyle fractures). Type I fractures of the proximal femur carry a very different prognosis with age; in the infant the growth plate is extracapsular and well ossified, in the adolescent, the growth plate is intracapsular and the blood supply travels a precarious path up the intracapsular femoral neck.

Resection of established physal bridging between the metaphysis and epiphysis has been effective in re-establishing growth if the bony bridge is not too large, and the duration of the bridge is not too long. Obviously, injuries such as those secondary to lawnmower injuries which include large injuring forces can produce further direct damage to the resting zone on both fragments can further complicate recovery of the physis and increase the possibility of physal bridging. In such instances, careful monitoring of further growth of the affected physis is mandatory. The need for follow-up after physal injuries is often not recorded in the literature, but documentation of further normal growth after a physal fracture seems a very reasonable requirement before discharging a patient from further follow-up after physal injury.

References

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