Fractures around the knee in children include epiphyseal and metaphyseal fractures, injuries of the growth plate, fractures of the distal femur and proximal tibia, avulsion fracture of the tibial spine, fracture of the tibial tubercle, and fracture or dislocation of the patella with osteochondral fractures.

The epiphyseal injuries around the knee are rare, accounting for 1% to 6% of all epiphyseal injuries. These injuries can occur at any age in a growing child, with the highest incidence between ages 11 and 15 years. The ligamentous injuries frequently seen in adults are rare in children.

Other complications may occur with a different degree of severity. These include injuries to the popliteal artery and peroneal nerve, stiffness of the knee, quadriceps atrophy, and osteoarthritic changes of the articular cartilage.

Treatment of these injuries requires anatomic reduction of the articular surface and growth plate. The avulsed tendons and ligaments should be repaired. The fractures heal fast in children and the period of immobilization does not exceed 4 to 6 weeks. All patients require a period of rehabilitation to regain strength and motion after a significant knee injury.

SURGICAL ANATOMY

The distal femoral epiphysis contains the medial and lateral condyle. The lateral border of the lateral condyle is in line with the lateral cortex of the diaphysis. Just proximal to the medial border of the medial condyle the metaphysis flares out to the adductor tubercle. On the posterior surface the condyles are separated by a deep intercondylar notch, which extends to the midpoint of each condyle. On the anterior surface the lateral condyle is almost vertical, while the medial condyle is more flattened and C-shaped.

Most of the external surface of the distal femoral epiphysis is covered by the articular cartilage for articulation with the patella and upper tibia. The tibial surface of each femoral condyle extends to the posterior surface, and the articular cartilage reaches the posterior margin of the distal femoral growth plate. The anterior surface of the femoral epiphysis has a shallow concave midline to accommodate the vertical ridge of the undersurface of the patella.

The distal femoral growth plate is horizontal. It extends from the adductor tubercle to just above the lateral epicondyle. It is slightly tilted anteriorly. The proximal tibial epiphysis has a slightly concave surface. The medial and lateral sides are separated by the anterior and posterior tibial eminence. The distal surface of the tibial epiphysis is concave to match the convex upper end of the proximal tibial metaphysis. The height of the epiphysis is greater on the lateral surface than on the medial side. The growth plate slopes downward and anteriorly, and extends distally under the tibial tubercle. The tibial tubercle is a downward projection of the tongue of the proximal tibial epiphysis.

The position of the growth plate in the distal femur is extraarticular. The suprapatellar pouch bulges up superiorly over the anterior surface of the distal femoral metaphysis. The synovial membrane, posterior capsule, and all the ligaments are attached to the femoral epiphysis, just distal to the growth plate. The medial and lateral collateral ligaments are also attached to the distal femoral epiphysis below the growth plate. The plan-
taris and two heads of the gastrocnemius muscle originate from the upper margin of the posterior surface of the distal femoral metaphysis. On the tibial side the synovial membrane and the capsule are attached to the proximal tibial epiphysis proximal to the growth plate. The cruciate ligaments are attached to the anterior and posterior tibial eminence. The lateral collateral ligament is attached to the fibula, and the medial collateral ligament is attached to the upper tibial metaphysis beyond the growth plate. The patellar ligament is attached to the tibial tubercle and superficial to the downward extension of the growth plate. The ligament then spans to either side of the tubercle and finally it is connected to the deep fascia in the upper tibial diaphysis. The patellar ligament is reinforced by the medial and lateral retinaculum. The semimembranosus tendon inserts on both the epiphyseal and metaphyseal side of the growth plate in the posteromedial corner of the proximal tibia.

The patella is the largest sesamoid bone in the body. It lies deep to the quadriceps tendon, with strong attachment of the extensor mechanism to its surface.

Due to the anatomic position and bony configuration of the knee joint, the stability and strength of the knee is provided by the ligaments and tendons that surround it. A strong force puts tension on the ligaments and strain on the adjacent bone. When the amount of the force exceeds the resistant strength of the bone, the epiphysis will separate from the metaphysis.

The popliteal artery is in close proximity to the posterior surface of the distal femur. It is separated from the distal femoral metaphysis by a thin layer of fat. The superior geniculate arteries are branched just above the femoral condyle. The popliteal artery continues distally and lies on the posterior capsule of the knee joint. The distal portion of the popliteal artery is separated from the posterior aspect of the upper tibia by the popliteus muscle. The inferior geniculate arteries originate at this level and enter the proximal tibial epiphysis. Under the soleal arch, the popliteal artery divides into the anterior and posterior tibial arteries.

The epiphysis of the distal femur and proximal tibia have a rich blood supply from anastomosis of the genicular arteries. Abundant blood supply in this region makes it less vulnerable to ischemic changes following injuries. The blood supplies of the patella are mainly from the superior and inferior genicular arteries, supreme genicular artery, and anterior recurrent tibial artery. Anastomosis from branches of these arteries covers the anterior surface of the patella and enters the patella in the middle third of the patella.

The popliteal artery and its branches are prone to injury from a backward thrusting of the end of the distal femoral metaphysis at the time of the hyperextension injury, or by posterior displacement of the proximal tibial metaphysis during a physeal fracture of the proximal tibia.

Above the popliteal space, the sciatic nerve divides into the peroneal and posterior tibial nerves. The peroneal nerve travels between the biceps femoris muscle and the lateral head of the gastrocnemius muscle, to the level of the neck of the fibula. The stretching of the peroneal nerve can occur during a varus tilt and medial rotation of the distal femoral epiphysis. Moreover, the superficial location of the peroneal nerve subjects it to direct contusion from a blow on the posterolateral aspect of the knee.

CLASSIFICATION OF EPIPHYSEAL FRACTURES

The Salter-Harris classification on the epiphyseal fracture is the most commonly used classification and is based on the radiographic finding of the fractures (Fig. 21.1). Ogden has expanded the Salter-Harris classification by adding more subdivisions based on the different types of the epiphyseal injuries, including intraarticular injuries.

Type I: There is complete separation of the epiphysis from the metaphysis, without any fracture of the epiphysis or metaphysis.

Type II: The fracture is through the epiphyseal plate and extends through the metaphysis. A triangular segment of the metaphysis (Thurston-Holland sign) is attached to the epiphyseal plate.

Type III: The fracture is intraarticular, through the physis, and it extends to the epiphysis.

Type IV: The fracture is intraarticular. The longitudinal fracture line starts from the metaphysis, crosses the growth plate, and exits through the epiphysis.

Type V: The injury entails crushing or impacting of the growth plate with little or no displacement. This type of injury may not be visible on the initial film. In this instance, magnetic resonance imaging (MRI) demonstrates the impaction of the growth plate, marrow edema, and subperiosteal bleeding (Fig. 21.2).

Type VI: Mercer Rang has added this type to the classification. This is a localized injury to the perichondrial ring. A small fragment including a portion of the perichondrium and underlying bone is avulsed (Fig. 21.3). This may not be initially appreciated on the x-ray, especially if the avulsed fragment is very small. Following healing of the fracture, the bony bridge may cause angular deformity.