Ryu and Debenham Type IV-A Proximal Tibia Epiphysiolysis. A Case Report

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ABSTRACT
Epiphysiolysis of the proximal tibia is a rare injury due to the surrounding structures that protect the area. In displaced fractures, the evaluation of vascular structures is mandatory to detect injury to the popliteal artery or the presence of compartment syndrome. We present a Salter & Harris type I epiphyseal injury of the proximal tibia in a 10-year-old boy.
Key words: Proximal tibia; epiphysiolysis; Kirschner wires; vascular injury; compartment syndrome.
Level of Evidence: IV

Epifisiólisis tibial proximal tipo IV-A de Ryu y Debenham. A propósito de un caso

RESUMEN
Las epifisiólisis tibiales proximales son un cuadro poco frecuente debido a la protección que aportan las estructuras circundantes de dicha zona. Por el desplazamiento que se origina es necesario realizar una exploración vascular junto a una reducción urgente para prevenir la lesión de la arteria poplítea y la aparición de un síndrome compartimental. Presentamos a un varón de 10 años con epifisiólisis de tibia proximal tipo I de Salter-Harris.
Palabras clave: Tibia proximal; epifisiólisis; agujas de Kirschner; lesión vascular; síndrome compartimental.
Nivel de Evidencia: IV

INTRODUCTION

Injuries the proximal epiphysis of the tibia are rare, accounting for 0.5-3% of all epiphyseal injuries.[1] The peculiarity of this type of injury lies in the arrangement of the ligaments of the knee, which protects the proximal tibial epiphysis. They are more frequent in male adolescents and the risk is higher in obese people who are growing rapidly.[1] There is a high risk of popliteal artery injury due to posterior displacement of the metaphysis and of developing compartment syndrome. Therefore, it is essential to carry out an exhaustive vascular evaluation, and reduce and stabilize the fracture urgently. Some added complications may be alterations in physeal growth, ligament and meniscal injury, and knee instability.[2]

We present the case of a 10-year-old male with a Salter-Harris type I epiphysiolysis of the proximal tibia.

CLINICAL CASE

A 10-year-old male was admitted to the pediatric emergency department due to trauma to his left knee while playing soccer. He reported amnesia for the episode.

Physical examination revealed significant knee swelling, inability to walk, intense pain with flexion-extension, and presence of distal vascular pulses. It was not possible to assess the stability of the knee due to pain.

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Anteroposterior and lateral radiographs of the left knee were requested, in which an epiphyseal fracture corresponding to type I Salter-Harris and type IV-A of the Ryu and Debenham[3] classification was observed (Figure 1). After informing the patient and his parents, urgent surgical treatment was decided. The fracture was treated with closed fixation with two Kirschner wires (Figure 2). There was no knee instability. The evaluation detected the presence of distal pulses and the pulse oximeter examination also showed values within normal limits. He was immobilized with a long leg splint.

Figure 1. Anteroposterior and lateral radiographs of the left knee.

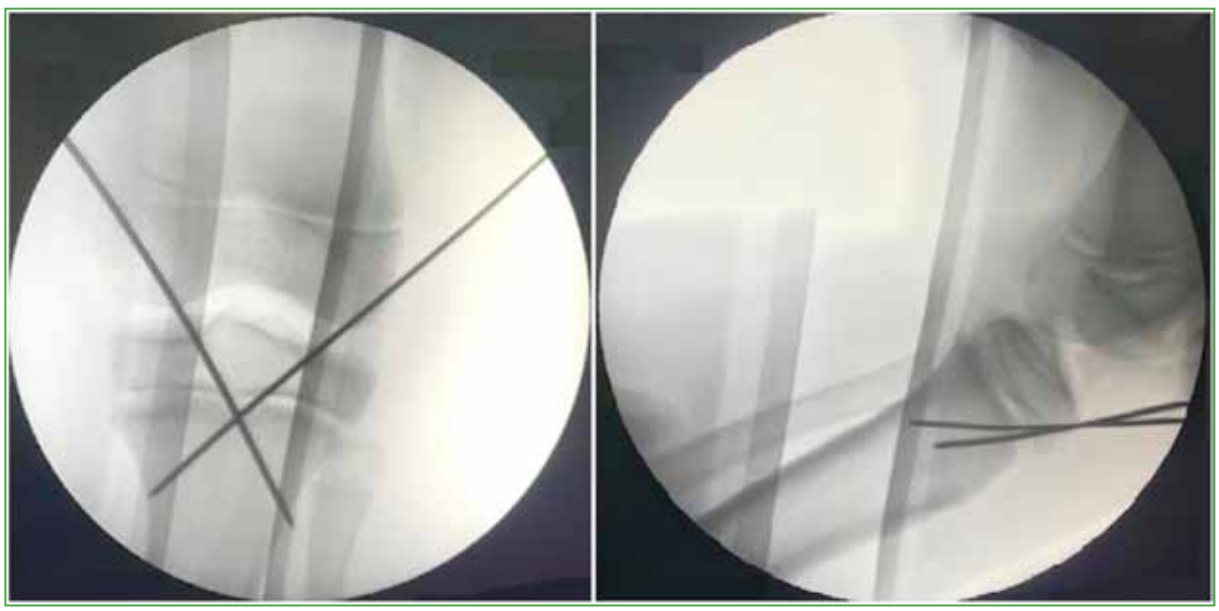

Figure 2. Control fluoroscopy of the reduction in the operating room.

When the patient recovered from the anesthesia, the pain had improved and finger mobility was painless. Immobilization was maintained for four weeks and no weight-bearing was allowed. Subsequently, the immobilization and the pins were removed, and free flexion-extension and walking aided by canes were allowed for two more weeks (Figure 3).

Figure 3. A and B. Postoperative control anteroposterior and lateral radiographs of the left knee. **C and D.** Anteroposterior and lateral radiographs of the left knee one month after the injury with needle removal.

Knee radiographs and physical examinations were performed monthly until six months post-injury, then biannually until two years post-injury. No alterations were seen in the proximal tibial physis and no angular alterations have appeared in the knee, which remains stable (Figure 4). Annual check-ups will be maintained until the patient reaches skeletal maturity to rule out growth disturbances.

Figure 4. Measurement of the lower limbs two years after the injury.

DISCUSSION

Epiphyseal fractures of the anterior tibia have a low incidence, representing 0.5-3% of all epiphyseal injuries.[1] This is because most physeal injuries are caused by ligament traction and the proximal tibial epiphysis lacks them (except the insertion of cruciate ligaments). In addition, the wide contact surface with the metaphysis and the circular protection provided by the structures adjacent to the proximal tibial physis reduce the risk of these injuries. Laterally, the proximal tibial epiphysis rests on the fibula, the inner part is on the distal insertion of the superficial layer of the medial collateral ligament and the insertion of the semimembranosus muscle, which protects the posteromedial angle. Anteriorly, the anterior tibial tuberosity assists in preventing posterior displacement of the tibia. Moreover, the inclined arrangement of the physis provides excellent stability.[4]

Traditionally, epiphyseal injuries of the proximal tibia have included those that affect the anterior tibial tuberosity and those caused by separation of the physis. Initially, the Salter and Harris classification, the Watson-Jones classification, and its subsequent modification by Ogden were used, but these were limited to involvement of the anterior tibial tuberosity until, in 1985, Ryu and Debenham included a new type (IV) characterized by propagation towards the posterior cortex (type IV-A without cortical involvement = Salter-Harris type I) (type IV-B with cortical involvement = Salter-Harris type II) (Figure 5).[3]

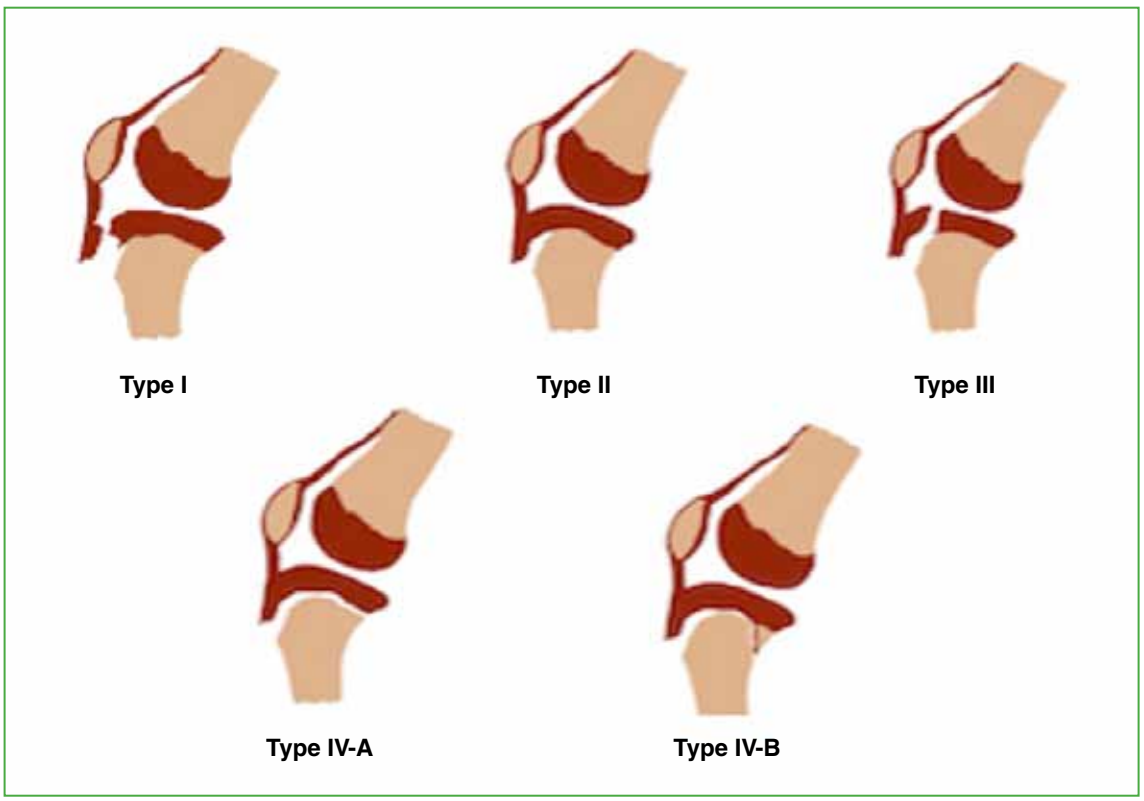

Figure 5. Ogden classification modified by Ryu and Debenham.

This type of fracture can be caused by a direct impact (traffic accident, direct blow during sports practice) or by indirect forces. In 1966, Silberman and Murphy[5] elaborated a hypothesis about its origin that consists of an avulsion caused by an overload of traction forces on the proximal tibial physis during the take-off phase of a jump in which the knee is in flexion. When analyzing these injuries in patients who played basketball (the sporting activity that is most frequently associated with this epiphyseal injury), Steiger and Ceroni[4] established that the pathophysiology would consist of an eccentric muscle contraction with which the muscle lengthens against resistance, absorbing energy that is transmitted to the proximal tibial epiphysis. This same principle would occur in the takeoff phase of the jump, as in landing or sudden stops. In older patients, a Salter-Harris type II epiphyseal fracture (Ryu and Debenham type IV-B) would occur due to ossification of the posterior region of the physis.

The risk is higher in adolescent and obese males.[1,4] This difference in distribution according to sex is due to the fact that these injuries occur more frequently in sports, especially when the physical demand is greater (adolescence). Women present a complete or almost complete ossification of the proximal tibial physis, and ligament injuries are more frequent.[4]

The initial diagnosis is based on anteroposterior and lateral radiographs of the knee. Initially, these tests will suffice, but if a type III or IV epiphyseal fracture is suspected, a computed tomography should be requested to assess the extent of the fracture and even an MRI to determine possible damage to soft tissues, such as the menisci or cruciate ligaments.

The treatment is based on achieving the anatomical reduction of the area to avoid alterations in the growth and stability of the knee. When there is no displacement, conservative treatment with a long leg plaster cast for 4-6 weeks can be chosen. If, on the other hand, the displacement is >2 mm, as in our case, reduction should be used, preferably closed, and fixation with Kirschner wires. This osteosynthesis must be introduced from proximal to distal through the non-articular part of the tibial epiphysis and must cross distal to the physis to achieve rotational stability.[6]

The eventual posterior displacement of the tibial metaphysis increases the risk of injury to the popliteal artery, which is attached by firm connective tissue septa to the posterior aspect of the joint capsule, limiting its deviation to adaptation. For this reason, the injury must be reduced and stabilized and close attention must be paid to the vascular status by exploring the pulses.[7] Likewise, intracompartmental pressure can increase due to inflammation, increasing the risk of compartment syndrome. This increased pressure in the proximal tibial area is due to the possible injury of a recurrent branch of the anterior tibial artery that runs along the lateral border of the anterior tibial tuberosity.[8] The incidence varies considerably depending on the series consulted: 17-20% (Frey et al. and Palokoff et al.) and 4% (Pretell-Mazzini et al.).[9-11] The ligament structures, in principle more resistant than the physis, can be damaged, causing subsequent instability of the knee joint,[1,4] as well as meniscal injury. The incidence of injuries to these structures has not been published (they are fundamentally involved in type III or IV injuries) and are only reflected as case reports.[12,13]

Late complications may include limb length discrepancies and axial deformities. In different series, a difference in limb length >25 mm or axial deviation >5º was observed in 25% of patients.[14-16] This is due to a premature total or partial closure of the growth plate (Hasler, >30% of early closure in his series) or its overstimulation.[17] Periodic follow-up should be carried out with radiographs of both entire limbs to assess whether there are alterations and indicate early corrective measures. Follow-up should continue until complete ossification.

CONCLUSIONS

Epiphyseal fractures of the proximal tibia are rare. They are basically avulsions of the anterior tibial tuberosity. Male, overweight, and rapidly growing adolescents are at increased risk for this type of injury. The main complication is growth arrest in the long term; we must also pay attention to a possible injury to the popliteal artery. The goal of treatment is restoration of the anatomy either by closed reduction and immobilization, or open or closed reduction with internal fixation.

Conflict of interests: The authors declare no conflicts of interest.

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