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FRACTURES OF THE TIBIAL COLUMN (FCT), FRACTURES OF THE TIBIAL EMINENCE OR INTERCONDYLAR EMINENCE

Fernando Sebastián Pérez Páez[1], Marcos Antonio Sánchez Macías[2], Rafaela Denisse Zambrano Mendieta[3], Katherine Cecibel Barzola Suárez[4], Jennifer Paulette Pineda Valarezo[5], Bryam Esteban Coello García[6]

[1]General Practitioner In Independent Practice,Faculty of Medical Sciences, Universidad de las Américas. Quito-Ecuador ORCID https://orcid.org/0009-0009-6442-7680

[2]General Practitioner at "Hospital General Guasmo Sur", Faculty of Medical Sciences, Universidad Católica Santiago de Guayaquil. Azuay- Ecuador ORCID https://orcid.org/0009-0009-3317-6866

[3]General Practitioner at "Hospital General Guasmo Sur", Faculty of Medical Sciences, Universidad Católica Santiago de Guayaquil. Azuay- Ecuador ORCID https://orcid.org/0009-0009-2203-8070

[4]General Practitioner at "Hospital Básico Gualaquiza - Misereor", Faculty of Medical Sciences, Universidad Católica de Cuenca. Ecuador ORCID https://orcid.org/0009-0004-3264-3251

[5]General Practitioner at "Clínica la Cigueña", faculty of Medical Sciences, Universidad de Guayaquil. Ecuador ORCID https://orcid.org/0009-0002-0857-7595

[6]Postgraduate Doctor in Orthopedics and Traumatology at Faculdade de Ciências Médicas Minas Gerais. Belo Horizonte - Brasil. ORCID https://orcid.org/0000-0003-2497-0274

Corresponding Author: *Bryam Esteban Coello García* ***Address:*** *Rua Teresópolis 183. Belo Horizonte. Minas Gerais. Brasil.*
Postal Code: *31130050*

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ABSTRACT

Introduction: *Tibial spine fractures (TSCF), also called tibial eminence or intercondylar eminence fractures, are defined as bony or chondral avulsions of the tibial plateau at the point of insertion of the anterior cruciate ligament (ACL). It is equivalent in etiology to ruptures of the medial substance of the ACL in adults. Depending on the classification of the fracture, conservative or surgical treatment may be chosen.*

Objective: *to detail the current information related to tibial spine fractures, epidemiology, mechanism of action, classification, treatment and complications.*

Methodology: *a total of 38 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 27 bibliographies were used because the other articles were not relevant for this study. The sources of information were PubMed, Google Scholar and Cochrane; the terms used to search for information in Spanish, Portuguese and English were: fractures of the tibial spine, bone avulsions, fractures of the tibial eminence, fractures of the intercondylar eminence.*

Results: *the incidence of TSF in children and adolescents is increasing, being more prevalent in boys and in ages between 8 and 14 years. Non-surgical treatments are recommended for undisplaced or minimally displaced fractures, while more severe fractures, such as type III fractures, generally require surgical intervention. Surgical fixation with cannulated screws and sutures has proven to be effective, with good clinical and radiological results, especially in large or comminuted bone fragments. However, there are complications associated with both non-surgical and surgical treatment, with arthrofibrosis being the most common in surgical treatment. Early mobilization is crucial to avoid stiffness, and monitoring the position of the fragment with periodic radiographs is essential to ensure successful treatment.*

Conclusions: *Pediatric tibial spine fractures (TSF), although infrequent, are on the increase due to increased sports activity in children and adolescents, especially in boys aged 8 to 14 years. The mechanisms of injury are similar to those in adults, but incomplete ossification of the tibial plateau facilitates avulsion fractures in children. These are classified according to displacement and complexity, and MRI is key to their diagnosis and treatment. Early treatment is crucial to prevent complications, and arthroscopic surgery is preferred for its lesser impact on soft tissues and faster recovery.*

KEYWORDS: *Fractures, Tibial Spine, Avulsions, Tibial Eminence, Intercondylar Eminence.*

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INTRODUCTION

Fractures of the tibial spine (FCT), also called tibial eminence or intercondylar eminence fractures, are defined as bony or chondral avulsions of the tibial plateau at the point of insertion of the anterior cruciate ligament (ACL). They are infrequent, with an age peak in children and adolescents. It is equivalent in etiology to ruptures of the medial substance of the ACL in adults. With stress, the incompletely ossified tibial eminence in the child fails before the ligament through the cancellous bone below the subchondral plate. Usually, the fracture extends to the weight-bearing portion of the articular surface of the medial tibial plateau. Depending on the classification of the fracture, conservative or surgical treatment may be chosen. Reduction and internal fixation of fractures of the intercondylar eminence of the tibia by arthroscopy proves to be a reliable and easy to use technique. Arthroscopic surgery helps diagnose and treat other complications in the knee joint. Early functional exercise contributes to a rapid recovery of joint function(1,2).
In the present study we will address the epidemiology, mechanism of action, classification, treatment and possible complications of tibial eminence fractures.

METHODOLOGY

A total of 38 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 27 bibliographies were used because the information collected was not sufficiently important to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar; the terms used to search for information in Spanish, Portuguese and English were: fractures of the tibial spine, bone avulsions, fractures of the tibial eminence, fractures of the intercondylar eminence.
The choice of literature exposes elements related to tibial spine fractures; in addition to this factor, epidemiology, mechanism of action, classification, treatment and possible complications are presented.

DEVELOPMENT

Epidemiology

They are infrequent, with an incidence of about 3 per 100,000 per year, the occurrence is increasing because of increased pediatric and adolescent sports activity. These injuries are most common in skeletally immature individuals between 8 and 14 years of age and make up to 2-5% of knee injuries in children and adolescents evaluated for knee joint effusion. The incidence of pediatric SSTs is higher in males than in females(2-6).

Mechanism of Action.

The classic mechanisms of injury are forced knee flexion with simultaneous tibial external rotation, uncontrolled tibial external rotation combined with a planted foot or knee hyperextension with a valgus or rotational force. The mechanisms are similar to those that generate ACL tears in adults, in which the overloading tensile force generated to the ligament causes an intrasubstance injury. In children, avulsion fractures occur more easily because the strength of the incompletely ossified tibial plateau is less than that of the ACL(7,8).

Classification

They are usually classified by the Meyers and McKeevers (MM) classification system based on conventional radiographic images, created in 1959, which divides this type of fracture into type I, type II or type III. Subsequently, Zaricznyj modified this classification system by adding type IV.
Type I: simpler, non-displaced fractures of the medial tibial eminence.
Type II: the most anterior portion of the tibial spine is avulsed superiorly while the posterior portion remains attached to the tibial plateau in a hinge pattern.
Type III: completely displaced fragments totally separated from the fracture bed.
Type IV: displaced fractures with comminution of the fragment(2,9).

Nowadays, with the use of magnetic resonance imaging (MRI), it is possible to immediately identify associated soft tissue injuries, such as meniscal tears or osteochondral lesions, in addition to analyzing the size, pattern and displacement of the fracture fragments and assessing the integrity of the anterior cruciate ligament (ACL).

There is a Green's MRI grading system described below:
Grade I: undisplaced or minimally displaced fractures with ≤2 mm of displacement.
Grade II: posteriorly hinged fractures with >2 mm displacement of the anterior aspect and ≤2 mm displacement of the posterior aspect of the fragment.
Grade III: fractures with >2 mm displacement of the posterior aspect of the fragment, meniscal or intrameniscal ligament entrapment, or extension of the fracture to the loading surface of the medial or lateral tibial plateau.

This MRI-based classification system provides specific quantitative criteria to classify fractures according to fragment displacement and tissue entrapment, allowing for better decision-making in future treatment(10,11).

Associated Lesions

They include meniscal entrapment, meniscal tears, concomitant ACL medial substance injuries, chondral injuries, bone hematomas and tibial plateau fractures. The identification of soft tissue injuries is important, especially when the damaged tissue is interposed between the avulsed bone fragment and its bed, preventing a proper closed reduction and constituting an indication for surgical management. Some investigations showed entrapment of the anterior horn of the medial meniscus, intermeniscal ligament or anterior horn of the lateral meniscus in 26% of type II fractures and up to 65% of type III fractures. A longitudinal tear of the posterior horn of the lateral meniscus was the most commonly seen alteration, followed by detachment of the anterior root of the lateral meniscus, the latter specific injury pattern is essential to recognize as it represents a functional meniscectomy, and surgical reinsertion of the meniscal root is recommended(11-15).

Treatment

Timely diagnosis and treatment of tibial spine fractures (TSF) are essential to achieve full recovery and satisfactory results.

Most specialists suggest conservative treatment with immobilization for nondisplaced and mildly displaced TSFs that achieve successful closed reduction. The ideal position for immobilization with a cast is not clearly established, particularly as to whether the patient's knee should be kept fully extended or in 20° flexion. Those who prefer full extension believe that the fragment is reduced by direct compression of the lateral femoral condyle. However, other studies advocate that 20° knee flexion prevents anterior cruciate ligament (ACL) strains. Despite the immobilization position, specialists agree on the importance of radiographic follow-ups to verify the correct alignment of the fragment(6,16,17).

The treatment of type II fractures is not fully established. If the fragment has minimal articulation without meniscal soft tissue entrapment, closed reduction may be attempted. If this is successful, the knee should be immobilized with a splint or cast for a period of 4 to 6 weeks; in addition, periodic imaging studies are necessary to monitor for any displacement in the first few weeks after diagnosis. In case of an incorrect reduction or displacement, as well as if the initial fracture displacement is greater than 5 mm or there are associated injuries that need repair, reduction and surgical fixations should be considered(18,19).

Type III tibial spine fractures generally require surgical intervention. Conservative treatment in these cases may lead to increased pseudarthrosis, increased residual laxity and increased loss of range of motion (ROM). Surgical treatment can be open or arthroscopic. A recent multicenter study showed that internal fixation by arthroscopic reduction (ARIF) and internal fixation by open reduction produce successful results in pediatric SSTs, with no significant differences in outcomes or pseudarthrosis between the two groups, although a greater number of concomitant lesions will be obtained in patients treated with ARIF. Arthroscopic treatment is preferred because of smaller incisions, less soft tissue damage, better pain control, shorter hospitalization period and faster ROM recovery. In addition, arthroscopic treatment allows associated soft tissue injuries such as tears and meniscal entrapment to be effectively addressed(6,20,21).

Successful surgical treatment of tibial eminence fractures depends on secure fixation, timely treatment and early mobilization. However, surgery also aims to address associated soft tissue injuries such as meniscal tears, meniscal and intermeniscal ligament entrapment, ACL tears, and removal of loose fragments in the joint. Various fixation methods are available to treat these injuries, including sutures, suture anchors, suture bridges, cortical buttons, screws (cannulated or solid, metal or absorbable, traditional or headless), K-wires, metal pins, meniscal shaft devices, absorbable pins and staples. Evidence indicates that reliable fixation methods should be able to withstand a cyclic load of at least 300-450 N. Screws and sutures are the most commonly used implants(6,20,22).

Screw

Arthroscopy-assisted cannulated screw fixation for tibial eminence fractures is a reliable and well-documented treatment that offers positive clinical and radiological results. This technique is relatively simple, stable, inexpensive and allows early mobilization and ambulation. It is often the preferred option for larger bone fragments. However, the limitations of screws are linked to their possible anterior impingement, which could cause damage to the articular surface(21,23).

Sutures

Suture fixation is the preferred technique for small bone or cartilage avulsions, or when there is significant comminution of the fragments. High-strength sutures are placed at the base of the ACL and then passed through small tunnels to tie them over the anterior tibial cortex. Another alternative is to secure the sutures to the tibial plateau with anchors. Various suturing techniques have been described, using absorbable and non-absorbable materials(24,25).

Figure 1. TSF treated with Screws: Preoperative MRI and Postoperative Radiographs.

Source: Salvato D, Green DW, Accadbled F, Tuca M. Tibial spine fractures: State of the art. J ISAKOS(6).

Complications

Complications related to both nonoperative and operative treatment of tibial spine fractures (TSF) have been identified, such as arthrofibrosis, residual knee laxity, pseudarthrosis, poor healing, and growth arrest. Regarding nonoperative treatment, a recent systematic review revealed that persistent laxity, either

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objective or subjective (11.1%), and joint stiffness (19.4%) are the most frequent complications, being more common in more severe injuries.

Post-surgical arthrofibrosis remains the most common complication in surgically treated tibial spine fractures (TSF), with rates ranging from 10% to 29%. Longer surgical times have been associated with an increased risk of arthrofibrosis. Early mobilization is critical to prevent the stiffness associated with this condition; patients who begin range-of-motion (ROM) exercises within the first four weeks after surgery are 12 times more likely to develop arthrofibrosis if they begin rehabilitation later. On the other hand, residual laxity usually results from damage to the anterior cruciate ligament (ACL) during the initial injury, nonanatomic reduction of bony or cartilaginous avulsion, or re-injury in patients with risk factors for ACL tears.

Non-union of tibial spine fractures (TSF) in children is a rare complication, and only a few studies mention these cases in the literature. Growth arrest has been documented, which may result in deformities or leg length discrepancies after transfissural screw fixation. More recently, an isolated case of ipsilateral limb overgrowth after suture fixation of the tibial spine has been reported. Although these complications are rare, they required additional surgical intervention and could have been avoided with physis-sparing techniques. Therefore, it is crucial to prevent damage to the physis in skeletally immature patients(21,26-28).

CONCLUSIONS

Pediatric tibial spine fractures (TSF) are infrequent but increasing injuries, especially due to increased sports activity in children and adolescents. These fractures primarily affect individuals aged 8 to 14 years and tend to be more common in males. The mechanisms of injury are similar to those affecting adults, but in children, the strength of the incompletely ossified tibial plateau facilitates avulsion fractures. TSFs are classified into different types according to their displacement and complexity, with magnetic resonance imaging (MRI) providing a crucial tool for diagnosis and classification, helping to guide treatment decisions. Early treatment is essential to avoid complications such as pseudarthrosis and residual knee laxity, and arthroscopic surgery stands out as a preferable option due to its advantages, such as less soft tissue damage and faster recovery.

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