The Proximal Tibiofibular Joint Is Part Of The Knee

La articulación tibio fibular proximal es parte de la rodilla

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Rev Chil Ortop Traumatol 2023;64(2):e101–e108.

Abstract

The proximal tibiofibular joint is very stable, it is made up of 2 large ligament complexes, the anterior and the posterior, which makes its injury infrequent. Instability can occur atraumatically or traumatically, with anterolateral instability being the most common, with disruption of the posterior ligament complex. The clinical picture is variable; However, it is characterized by pain at the level of the fibular head and instability of the joint when examined. For its part, the imaging study begins with the AP and lateral x-ray, and may require further studies. It is a pathology that is usually underdiagnosed, which is why a high index of suspicion is required. Treatment is typically conservative and depends on the cause and timing of the injury. In cases of chronic instability, recurrence, or irreducibility, surgical intervention is likely necessary. Various techniques have been described in the literature, but no superiority has been demonstrated to date.

Keywords
- knee
- proximal fibular tibio
- knee instability

Resumén

La articulación tibiofibular proximal es muy estable, se compone por 2 grandes complejos ligamentarios, el anterior y el posterior, lo que determina que su lesión sea infrecuente. Puede producirse inestabilidad de manera atraumática o traumática, siendo la inestabilidad anterolateral la más habitual, con disrupción del complejo ligamentario posterior.El cuadro clínico es variable; no obstante, se caracteriza por dolor a nivel de la cabeza fibular e inestabilidad de la articulación al examinarla. Por su parte, el estudio imagenológico comienza con la radiografía AP y lateral, pudiendo requerir estudios de mayor envergadura.Es una patología que suele ser subdiagnosticada, por lo que se requiere de un alto índice de sospecha.El tratamiento suele ser conservador, va a depender de la etiología y la temporalidad de la lesión. En casos de

Palabras clave
- rodilla
- tibio fibular proximal
- inestabilidad de rodilla

received
November 22, 2022
accepted
August 14, 2023

DOI https://doi.org/10.1055/s-0043-1775877.
ISSN 0716-4548.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

inestabilidad crónica, recurrencia o irreductibilidad, es probable que se requiera de un tratamiento quirúrgico, para lo cual existen múltiples técnicas descritas, sin superioridades demostradas hasta la fecha.

INTRODUCTION

The proximal tibiofibular joint (PTFJ) and its pathology were described in detail for the first time in a case series published by Ogden in 1974.[1] It is a very rare injury; At that time there were only 108 cases reported in the literature.

Being a joint with multiple ligamentous and musculotendinous insertions, it is very stable, which gives it anatomical protection that determines a low injury rate.

Anatomy and Biomechanics

It is a synovial joint, which in 10% of cases has communication with the femorotibial joint through the subpopliteal recess. In 65% of cases, it has a trochoid shape; in 25%, a double trochoid shape and, in 10% of cases, a flat shape. The surface of the hyaline articular cartilage of the fibula has a triangular shape, while the tibial articular surface has an ovoid or circular shape.[2] More important than the joint shape is the orientation of the joint. 85% have an oblique orientation (>20° inclination), while only 15% have a horizontal orientation.[2] In his initial study, Ogden reported 70% oblique orientation and 30% horizontal orientation.[1] The relevance of joint orientation lies in the fact that the obliques have less rotational stability as they have a smaller joint contact area (26 mm^2 vs 17 mm^2).[3]

It consists of two large ligament complexes, anterior and posterior. The anterior complex is made up of 4 bands: an upper one (S), 2 middle bands (M1, M2) and a lower one (I). The tibial insertions of the bands are located on average at 12.5 mm (S), 15.9 mm (M1), 19.4 mm (M2) and 25.2 mm (I) distal to the joint interline, while the fibular insertions are 11.3 mm (S), 17.8 mm (M1), 24.1 mm (M2), and 27.0 mm (I) distal to the styloid. They have an average orientation of 51° (46°-56°) with respect to the joint interline.[4] (►**Fig. 1**).

The posterior ligament complex has 2 constant bands, an upper one (S) and a middle one (M). 20% of the cases reported in an anatomical-cadaveric study presented an additional lower band. The tibial insertion of the upper and middle bands is on average 13.4 mm and 21.0 mm respectively from the joint interline. In the fibula they insert at 8.0 mm and 20.1 mm respectively, distal to the apex of the fibular styloid. They have an orientation of 41.9° for the upper band and 38.2° for the lower band.[4] (►**Fig. 2**).

The anterior ligament complex has an average length of 47 + - 6 mm and width of 16 + -3 mm (area 761 +- 174 mm2), while the posterior ligament complex is smaller, having a length of 44 + −7 mm and width 13 + -3 mm (area of 565 + -103 mm2). These are the primary stabilizers of the joint, the anterior ligament complex being the main one, supporting up to 517 +- 144 N of tensile load (Ultimate Tensile Load) and presenting a rigidity (Stiffness) of 133 +- 39 N/mm. The posterior ligament complex supports up to 322 + -160 N of tensile load and 109 + -49 N/mm of stiffness.[5]

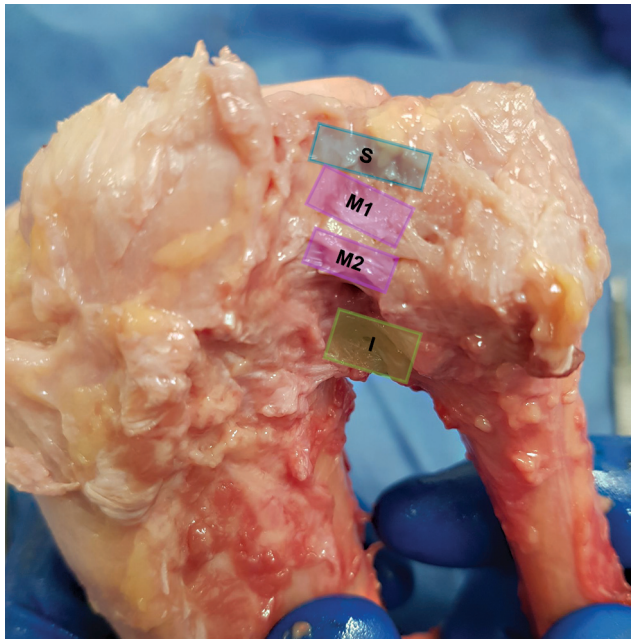

Fig. 1 Anterior view of the tibiofibular joint. The anterior complex is made of 4 bands: Superior (S), two middle (M1 and M2), and a inferior (I).

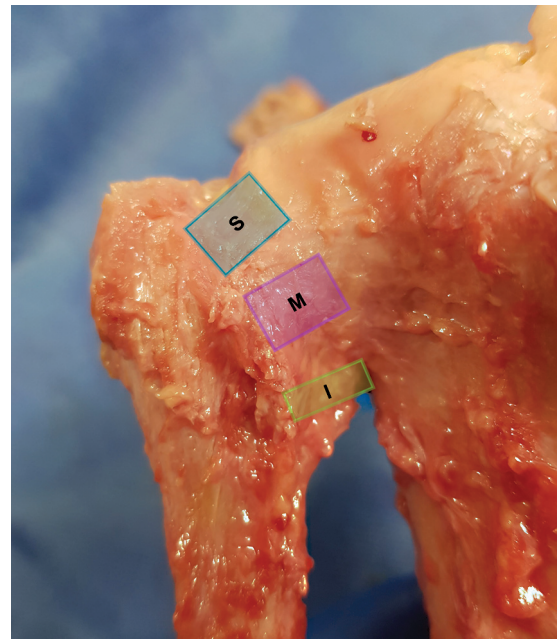

Fig. 2 Posterior view of the tibiofibular joint. The posterior complex is made of 3 bands: Superior (S), middle (M) and a inferior (I).

In addition, it presents as secondary stabilizers the different structures that are inserted around it, such as the biceps tendon, the lateral collateral ligament, the popliteus tendon, the arcuate ligament, the fabellofibular ligament and the popliteofibular ligament.[6]

Functions

Among its functions, the dissipation of torsional forces applied to the ankle, the transmission of axial load during walking (⅙ of the load passes through the fibula via the proximal tibiofibular joint), and the dissipation of lateral tibia torsional forces are described.[2]

Epidemiology

This is a very rare injury in its isolated form. In 1974, 108 cases were reported retrospectively. However, its real incidence would be higher, because it is a silent lesion, difficult to diagnose. In 1995 Semonian reported that 9 of 22 marathon runners studied presented hypermobility in the proximal tibiofibular joint.[7] The vast majority of publications found in the literature in this regard are case series, so there is no real incidence study.

Mechanism and Classification

Ogden proposed four types of PTFJ injuries[1]:

- **Type I**: ATRAUMATIC SUBLUXATION, mainly in hypermobile patients.
- **Type II**: ANTERO-LATERAL, the most frequent, up to 67% of cases. It presents a disruption of the posterior ligaments (weaker) and the fibula rotates around the anterior ligaments without breaking them. It is frequently associated with injuries to the lateral collateral ligament and the mechanism of injury would be falling on the knee in flexion with the foot in inversion or plantar flexion.
- **Type III**: POSTERO-MEDIAL: mainly caused by a direct blow to the lateral aspect of the knee in multiple traumas, it is frequently associated with injury to the common fibular nerve.
- **Type IV**: SUPERIOR, in high-energy injuries of the ankle, with compromise of the interosseous membrane (Maissoneuve dislocation).

Clinical Presentation

The clinical presentation is very varied. Cases of atraumatic subluxation should be suspected in the presence of lateral knee pain that increases when pressing on the fibular head in hypermobile patients, patients with Ehler-Danlos syndrome or muscular dystrophy. Also in pre-adolescent women, in which case, the symptoms tend to decrease as they reach skeletal maturity. It can occur in runner patients, when they increase the distances they are used to training.

Other atypical causes may be osteomyelitis, septic arthritis with involvement of the proximal tibiofibular joint, amputee patients, osteochondromas and growth disorders around the knee. Acute dislocations present pain, deformity and inflammation of the lateral aspect of the knee. They usually present with functional and weight-bearing limitations. Always suspect high-energy trauma, in cases of tibial plateau or shaft fractures, femur fractures, ankle dislocations or knee dislocation. Larger injuries evident in polytraumatized patients are frequently overlooked. Undiagnosed cases evolve into chronic or recurrent dislocation; where they present with a click or snap and lateral pain, a feeling of instability and failure, mainly when performing pivoting maneuvers. They may also present pain when climbing stairs, without clear symptoms, and may be confused with other knee pathologies.[3]

Physical examination

In general, these cases are underdiagnosed, since their stability is often not evaluated and, at the time of examination, it may be reduced but unstable. There should be a high index of suspicion in acute cases due to pain on palpation of the lateral aspect, which increases with dorsiflexion and eversion of the foot. In cases of PTFJ dislocation, the biceps femoris tendon is very tight. It should always be accompanied by a good neurological evaluation as it is in the context of high energy traumas.

In chronic cases, the "drawer sign" is described, in which, with the knee flexed at 90°, anterior and posterior translation of the fibula can be performed by gripping it between the thumb and index finger. This should be compared to the contralateral side for reference (►**Fig. 3**). There is also the Râdulescu Sign, which is described as an anterior

Fig. 3 Drawer sign, is performed with the knee flexed at 90°, then anterior and posterior translation of the fibula can be performed. This sign must be compared to contralateral side.

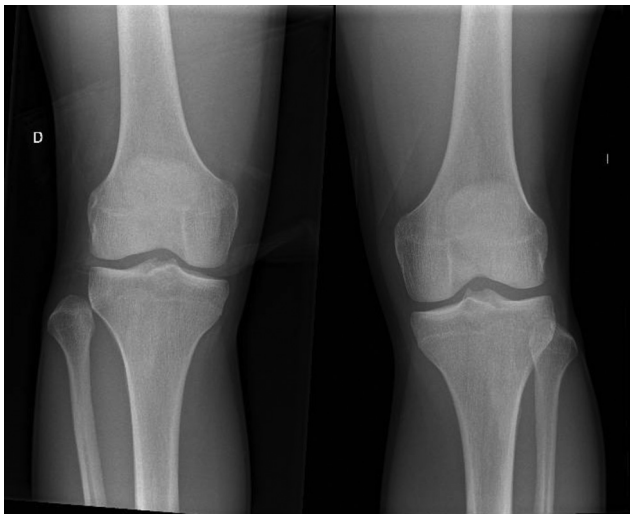

Fig. 4 Anteroposterior radiograph of both knees showing a dislocation of the proximal tibiofibular joint in the right knee.

Fig. 6 Frontal view of 3-D reconstruction of a CT scan confirming the luxation of the proximal tibiofibular joint in the right knee that had been suspected in the X-ray.

subluxation of the head of the fibula when internally rotating the foot, with the patient prone and the knee flexed at 90°.[3]

Imaging Study

The study should begin with simple knee radiographs, with anteroposterior and lateral projections. Fractures around the knee that raise the suspicion of a proximal tibiofibular injury should be ruled out. In a normal knee, the fibular head should overlap the posterior edge of the tibia; Furthermore, on the lateral radiograph, Resnick's line can be drawn, which longitudinally follows the lateral tibial spine distally, determining the most posteromedial region of the lateral plate of the tibia. This should normally cross the middle third of the fibular head.[8] (►**Figs. 4** and **5**). These parameters could be altered in the face of proximal tibiofibular injuries. In cases of acute trauma, computed tomography (CT) is the test of choice[9]; tibiofibular diastasis and/or presence of avulsion fractures can be observed in the coronal and sagital cuts (►**Figs. 6** and **7**). Magnetic resonance imaging (MRI) should be performed if suspected in cases of occult injury or chronic instability, in these cases ligament disruption or edema can be observed around the joint.[8,10,11] (►**Fig. 8**).

Ultrasound has also been studied as a useful diagnostic test, with the advantage of being a dynamic examination; The anterior ligament complex has been shown to have a visibility of up to 100% of its middle band, as for the posterior

Fig. 5 Lateral radiograph of both knee, showing the luxation of the right tibiofibular joint.

Fig. 7 Sagital view of 3-D reconstruction of a CT scan confirming the luxation of the proximal tibiofibular joint in the right.

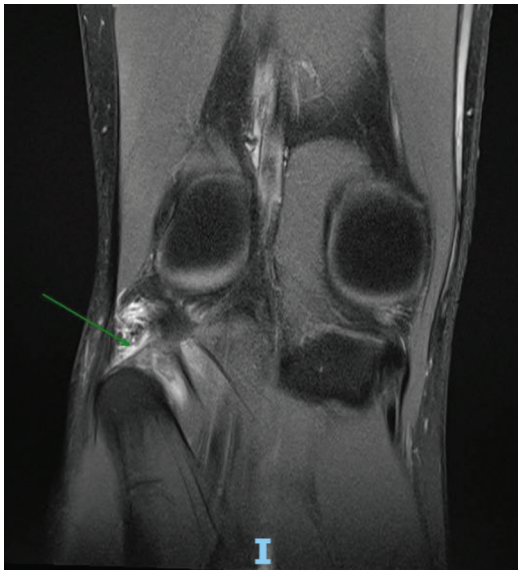

Fig. 8 Coronal view of a Magnetic resonance imaging (MRI) showing posterior complex disruption and edema in the proximal tibiofibular joint (green arrow).

ligament complex, the upper band has a visibility of 88.4%.[12] The disadvantage is that it is a dependent operator and the difficulty in identifying concomitant intra-articular pathology.

Treatment and Results

Management is poorly standardized; However, the trend remains conservative. Surgical treatment would be indicated in chronic refractory cases, acute cases with failed closed reduction or cases with compromise of the common fibular nerve.[4] Different alternatives have been proposed, from open reduction and fixation with Kirchner wires, screw fixation, resection of the fibular head, arthrodesis with or without fibular osteotomy, ligament repair and reconstruction.[13]

Fig. 9 Intraoperative fluoroscopy showing adequate reduction of the right proximal tibiofibular joint.

Conservative treatment

In atraumatic subluxations that have few symptoms or that have already resolved with age, the indicated treatment is conservative, due to the tendency to decrease laxity with age.

Acute dislocations are also managed conservatively, and a closed reduction must be performed with local anesthesia or sedation. The technique consists of positioning the knee in 60-90° flexion (flexion relaxes the biceps femoris and the lateral collateral ligament) while performing an inversion of the ankle. With the thumb, pressure must be placed on the fibular head so that it is reduced. If the reduction is stable, immobilization for 3 weeks is recommended, followed by progressive mobilization until completing 6 weeks[14] (►**Figs. 4**, **5** and **9**). In a systematic review by Kruckeberg et al, 35 conservatively treated cases were analyzed. Three cases had spontaneous reduction, 28 closed reduction and 4 did not receive any treatment. Immobilization protocols were variable. 59% of patients reported without residual symptoms. 15.4% returned to sport one year after the injury. Functional results were good, with an average Lysholm of 86 and average IKDC of 70. However, 23% presented poor results. In one of the studies analyzed, 8 patients presented persisted symptoms and had to undergo surgery; however, one persisted with chronic pain without reintervention and chronic instability.[15]

Surgical Treatment

In cases of closed reduction failure or in cases of chronic/recurrent instability or late diagnosis, surgical treatment is indicated. If closed reduction fails in an emergency,

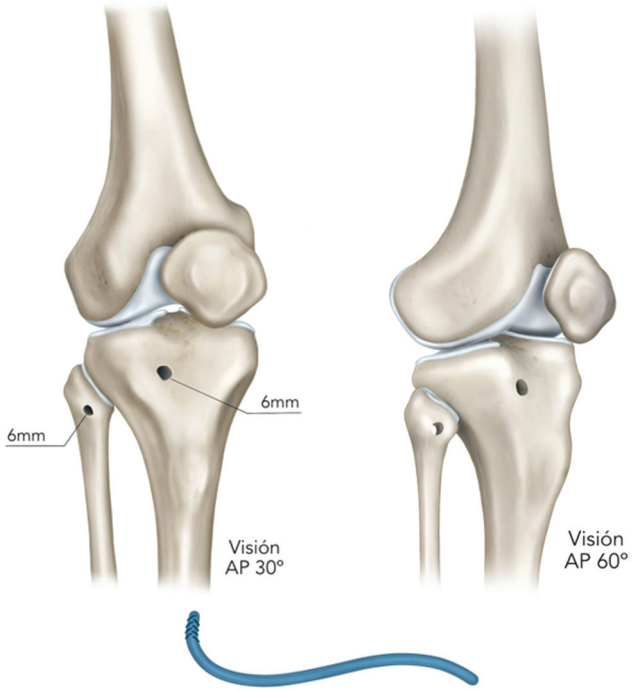

Fig. 10 Proximal tibiofibular reconstruction technique using two tunnels of 6 milimeters of diameter, one in the fibula head and the other in the proximal lateral tibia.

open reduction is indicated with primary repair of the damaged capsule and ligaments, associated with temporary fixation with a Kirschner wire or tricortical screw. It is very important in all open techniques (both repair and ligament reconstruction), the identification and protection of the common fibular nerve during the approach to avoid neurological injuries. Immobilization and unloading are indicated for 6 weeks, and then the osteosynthesis is removed (between 6 and 12 weeks) and rehabilitation begins.[14] Four cases in 3 studies were analyzed in the systematic review by Kruckeberg et al, all of them with acute management, obtaining 100% good clinical results, without residual symptoms, instability and return to normal functions. The average functional scores obtained were Lysholm 86 and IKDC 78.[15–18]

In cases of chronic/recurrent instability or late diagnosis and symptoms, ligament reconstruction is required, avoiding the complications of arthrodesis or resection of the fibular head. Different techniques have been described, such as tenodesis with iliotibial band or biceps femoris graft, or the use of free hamstring graft. If these techniques fail, arthrodesis or resection of the fibular head would be indicated.

The tenodesis with biceps femoris was described by Giacchino in 1986, in which a strip of the tendon of the long head of the biceps femoris is obtained, preserving its distal insertion in the fibular head and a strip of the fascia of the tibialis anterior, which is passed around the fibular head towards posterior; Then both ends are joined and passed through a tibial tunnel from posterior to anterior and fixed, in its original description, with sutures to the fascia anteriorly.[3,19]

Iliotibial band tenodesis, described by Shapiro in 1993, similarly uses a strip with preserved distal insertion, which is passed through a tibial tunnel from anterior to posterior, the exit of which should be at the insertion point of the proximal tibiofibular ligaments. Then, it must be passed through a tunnel through the fibular head from posterior to anterior, to later be fixed with sutures to itself.[3,20]

Regarding reconstruction with free graft, various techniques have been described. Kobbe in 2010, showed a technique with semitendinosus tendon, which is passed through a tibial tunnel towards the insertion of the anterior proximal

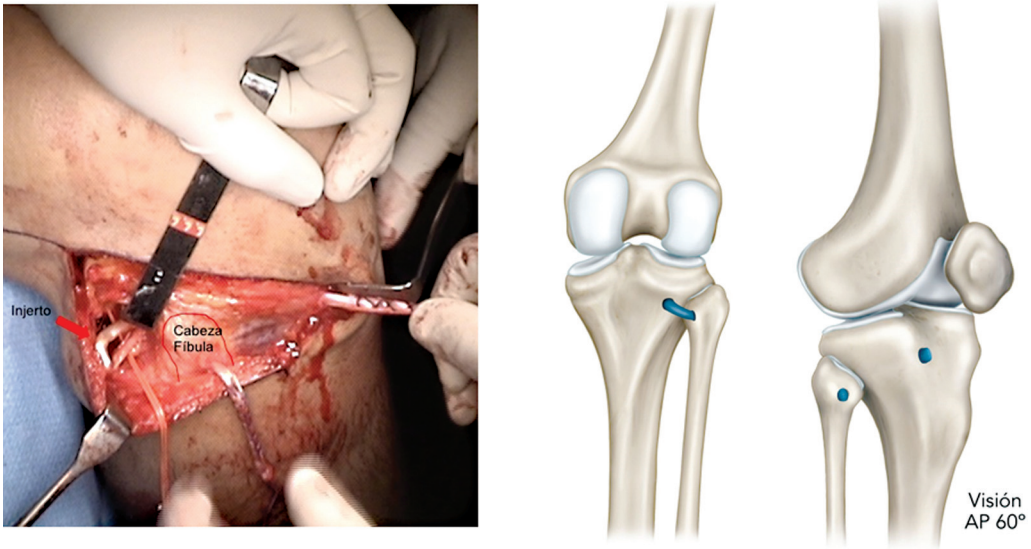

Fig. 11 The graft goes from anterior to posterior in the fibula, following the reverse path in the tibia. In the image on the right, you can see the schematic of the graft passage.

tibiofibular ligaments, then through a fibular tunnel from anterior to posterior and then another tibial tunnel from posterior to medial; Both ends are fixed with anchors and temporary fixation is performed with a Kirschner wire.[21] Maffulli described a similar technique with 2 parallel tibial tunnels, one proximal and one distal, and two fibular tunnels; presented 8 cases with 44 months of follow-up, obtaining sports return in 7 cases and without complications in their series.[22]

Another technique described is the use of a cortical suspension button and high-strength sutures (same device used for syndesmal fixation in ankle injuries).[23]Finally, Horst and LaPrade published an anatomical reconstruction technique with the semitendinosus tendon. A tibial tunnel is made from anterior to posterior, whose exit should be at the insertion of the posterior proximal tibiofibular ligaments, 1 cm medial and proximal to the tibiofibular joint; then, a fibular tunnel is made from anterolateral to posteromedial at 45° in the axial plane (►**Fig. 10**); Subsequently, the graft is passed through both tunnels and fixed with interferential screws (►**Fig. 11**). In their series, they recorded good functional results and absence of complications.[24] [Video link with surgical technique performed by the main author is attached: https://www.youtube.com/watch?v=t5srKQ6oitg]

The same LaPrade group published this same expanded series in 2020, with 16 cases and a minimum follow-up of 2 years. 81% of cases were secondary to non-contact sports injuries. In 14 cases there was an injury to the common fibular nerve to different degrees; However, 84.6% achieved their return to sports. 2 cases with complications were recorded; a patient with chronic neuropathic pain and a patient with femoral nerve paresis, which they attribute to the anesthetic block. The functional results on average were a Lysholm of 75 and satisfaction 7.6/10.[25]

The systematic review by Kruckenberg et al analyzes the results of different reconstruction series, both with different types of graft and types of fixation. A total of 22 patients were analyzed. In 18 they obtained clinical improvement (complete ROM, without pain, stability and return to function). 91% of patients were asymptomatic at the end of follow-up. In patients with reconstruction with free semitendinosus graft, the average IKDC was 74. In patients with biceps femoris tenodesis (8 cases), all returned to sport in a range of 6 weeks to 17 months, the average being 4 months.[15] It describes that in addition to the known neurological lesions, there may be other complications such as heterotopic ossification in cases of reconstruction with cortical suspension.

Finally, if the reconstruction fails, arthrodesis with internal fixation may be indicated, which reports good results with 62.5% stability achieved. However, they present 28% of complications (common fibular neurological deficit, need to remove osteosynthesis, infections and stress fractures of the fibula). In 10 cases from 4 studies of fibular head resection, 80% of patients were reported without symptoms at the end of follow-up, but with the remaining 20% of complications; a patient with neurological deficit and a patient with chronic pain in the lateral region of the thigh.[15,26–29]

CONCLUSION

PTFJ instability is a rare and often underdiagnosed clinical entity. It is essential to suspect it in acute cases of lateral knee pain after a torsional injury. In chronic cases it is important to examine it and rule out a residual lesion not previously investigated.

When conservative treatment has not provided satisfactory results, surgical stabilization with known and reproducible techniques has good results; However, there are no clinical studies in the literature that determine the optimal technique for each case.

We present a review work accompanied by clinical cases depicted in the images, which enables a comprehensive understanding of a topic that is often challenging to diagnose and treat.

Conflict of Interest
Dr. Roberto Negrin reported Honoraria for lectures received from Smith and Nephew.
All other authors reported no conflict of Interest.

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