Proximal Tibiofibular Joint: An overview

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ABSTRACT

Proximal tibiofibular joint is a frequently neglected joint which can be a source of lateral knee pain. Open surgery is the current mainstay of surgical management of proximal tibiofibular joint disorders. The proximal tibiofibular arthroscopy allows access to the joint and adjacent important ligamentous structures. This forms the basis of further development of arthroscopic procedures for a variety of pathologies.

Introduction

Disorders of the proximal tibiofibular joint can be the cause of lateral knee pain. In the presence of communication with the knee joint, it may be considered as the fourth compartment of the knee to explain subtle knee problems. We reviewed the anatomy, biomechanics, function, and pathologies of the joint, and treatment by open surgical approaches. Proximal tibiofibular arthroscopy is a feasible alternative to the open approaches and forms the basis for further development of arthroscopic procedures of the joint.

Anatomy

The proximal tibiofibular joint (PTFJ) is an arthrodial sliding joint located between the lateral tibial condyle and the fibular head. It is a synovial joint with hyaline cartilage articulation. A fibrous capsule surrounds the articulation with two prominent ligaments, the anterior and posterior proximal tibiofibular ligaments. The posterior capsule also consists of the popliteofibular ligament which runs from the fibular head to the popliteus tendon. Stability of the joint is provided by the ligaments, interosseous membrane, fibular muscles, and the distal tibiofibular joint.

Nerve supply

The common peroneal nerve is in close proximity to the PTFJ as it passes posteriorly over the neck of the fibula. In the popliteal fossa, the common peroneal nerve gives off genicular branches, the lateral sural cutaneous nerve, and a sural communicating nerve. The genicular nerves innervate the tibiofibular joint and PTFJ.

Ligaments

The lateral collateral ligament originates from the lateral epicondyle of the femur and runs distally to the head of the fibula, anterior to the styloid process.

The anterior proximal tibiofibular ligament attaches to tibia posterior to Gerdy tubercle. It courses linearly in the anterior—posterior direction and attaches anteroinferiorly to the fibular styloid. The fibular footprint is immediately anterior to the insertion of the biceps femoris. The ligament is frequently fused intimately with the biceps femoris tendon.

The posterior proximal tibiofibular ligament locates directly inferior to the lateral joint space of the knee. The ligament orientation is linear with minimal obliquity either superior or inferior. The fibular footprint is posterior to the insertion of the biceps femoris, which is posteroinferior to fibular styloid. The posterior ligament is always well defined.
The interosseous membrane runs obliquely between the borders of the tibia and fibula. The ligament of Barkow is deep in the muscles of the anterior compartment of the leg just superior to the interosseous membrane. Cadaveric study by Tubbs et al. shows that it can be identified in 95% of the specimens (38 out of 40), on average 3 cm below the PTFJ. It is in close approximation to the anterior tibial artery as it travelled into the anterior compartment of the leg. Based on its location, the ligament of Barkow may provide resistance to internal rotation, lateral, and posterior displacement of the PTFJ.1

The PTFJ is the site of attachment of numerous structures which help stabilize the tibiofemoral joint. These include the fibular collateral ligament (FCL), the capsular arm of the short head of the biceps femoris, the fabellofibular ligament, the popliteo-fibular ligament, and the popliteus muscle.

Types of articulation

Ogden1 classified variations of the PTFJ into oblique and horizontal types. Anatomic and radiological surveys showed that the inclination of the joint surface varied from 0° to 76°. The classification based on the inclination of the joint surface: joints with >20° inclination were termed the oblique type and joints with <20° inclination were termed the horizontal type.

The horizontal type is associated with increased rotatory mobility and joint surface area. The oblique type is associated with less rotatory mobility and joint surface area. Because the oblique type is less able to accommodate torsional stresses than a horizontal type, it would be expected that the oblique type would be dislocated more frequently. In a series of 43 patients with subluxation and dislocation of the joint reported by Ogden, 70% of the involve joints were oblique type.

Communication with knee joint

Resnick et al.3 described the developmental anatomy of the PTFJ and found that it did not possess a cavity before 12 weeks fetal age. Subsequently, narrow cavities that may be separated from the lateral tibiofemoral joint by a small amount of loose fibrous or areolar tissue are apparent.

Ogden1 reported that the percentage of this communication has been reported to be between 10% and 12%. More recent cadaveric study of the proximal tibiofibular joint using magnetic resonance imaging (MRI) arthrography by Bozkurt et al.2 showed nine out of 14 of specimens (64%) had a clear communication between the PTFJ and the knee. Complete communication between the two synovial spaces may be caused by an attenuated or absent fibrous septum. The incidence may be higher in the posttraumatic population in which this septum may be torn as part of the injury complex.10

This communication may be clinically important because either joint may be affected when joint pressure is elevated. Additionally, the PTFJ might be considered as the fourth compartment of the knee to explain subtle knee problems.2,11

Biomechanics

The PTFJ demonstrates motion during knee flexion—extension, tibia rotation, and ankle dorsiflexion. The tibia and fibula move relative to one another at the PTFJ with coupled motion through the interosseous membrane and the distal tibiofibular syndesmosis.1,14

Knee flexion—extension

With knee flexion, the fibula tended to move anteriorly, due to relaxation of the fibular collateral ligament and the biceps. In extension of the knee, as the ligament and biceps tighten, the proximal fibula is pulled posteriorly.1

Tibia rotation

Biomechanical study by Scott et al.12 demonstrates fibular translation was mainly influenced by internal—external rotation torque. The fibula translated anteriorly when the tibia was externally rotated, and posteriorly when the tibia was internally rotated. The greatest motion was seen in combination loading of varus and external tibial rotation at all flexion angles. Translational motion of 1–3 mm was observed during torques and forces that correspond to physiologic motions such as gait and stair climbing. Considering the small size of the joint (<10 mm), such translations may correspond to substantial soft tissue strain. Knee joint dysfunction could cause dysfunction in this joint and, subsequently, clinical symptoms.

Ankle dorsiflexion

The fibula rotates externally during dorsiflexion of the ankle joint.1,11 Barnett et al.15 found the greatest correlation existed between the anatomical shape of the PTFJ and the dorsiflexion axis of the ankle. During ankle dorsiflexion, the medial side of the talus remains coplanar, whereas the plane of the lateral side rotates, thus creating a changing inclination of the dorsiflexion axis. To accommodate this lateral planar rotation of the talus, the fibular must rotate externally about its longitudinal axis. The greater the dorsiflexion axis, the greater degree of external rotation of the fibular is necessary and a horizontal PTFJ is present. By contrast, in Barnett et al.’s Type III joint (inclination > 30°) with a relatively immobile fibula, the inclination of the dorsiflexion axis was small.

Rotation of the fibula during flexion—extension motion of the ankle joint plays a significant role in knee kinematics. In the course of this rotation of the fibula the meniscocubital ligament moves the lateral meniscus by pulling it backward and outward in the direction of its fibers. The meniscocubital ligament is thicker in horizontal PTFJs than in oblique PTFJs due to greater loading.

Function

The functional importance of the proximal tibiofibular joint was stated by Ogden1 as dissipation of torsional stresses applied at the ankle, dissipation of lateral tibial bending moments, and tensile weight-bearing. It also plays an integral role in the lateral stability of knee joint.

In a relatively immobile, oblique PTFJ, forced ankle dorsiflexion beyond the normal range would probably introduce increased torsional stress in the fibula and render it more susceptible to fracture or dislocation.1 However, some patients who have undergone arthrodesis of the PTFJ show significant symptoms at the ankle at follow-up, implying that some degree of rotatory motion is essential at the PTFJ.1

The fibular had a weight-bearing function, with approximately one-sixth of the static load applied at the ankle being transmitted to the proximal tibiofibular joint. Part of this transmitted load may be absorbed through the interosseous membrane and distal tibiofibular syndesmosis instead.1,14

Pathology

Disorders of the proximal tibiofibular joint should be kept in mind in the evaluation of lateral knee pain. They include subluxation or dislocation, osteoarthrosis, rheumatic disease, ganglion or synovial cysts, synostosis, synovial chondromatosis, pigmented
villonodular synovitis, and hypomobility of the joint. Peroneal nerves can be at risk with pathologies of the joint either by compressive effect or formation of intraneural ganglion.

**Subluxation/dislocation**

Subluxation is defined as excessive, symptomatic anteroposterior motion without frank dislocation. The usual symptomatology was pain along the lateral side of the knee and leg. This could be elicited by direct pressure over the fibular head.7

There are two varieties of PTFJ subluxation: idiopathic and postdislocation. The idiopathic cases show a bimodal distribution, being particularly prevalent in preadolescent girls, with a gradual decrease in frequency as skeletal maturity is approached. The older age group appears to be patients in the late forties and fifties with continued generalized laxity of ligaments. In the older group functional compromise of the peroneal nerve is common.15 Traumatic cases may be sports activities or violent trauma to the knee leading to anterolateral, posteromedial or superior dislocation (Figure 1).7

**Osteoarthritis**

Osteoarthritis of the PTFJ may be seen in knees with concomitant osteoarthritis of other compartments. Espregueira–Mendes and da Silva8 conducted a cadaveric study of 20 knees. Donors were all male with an average age of 50 years old (range 35–64 years). The macroscopic appearance of the articular cartilage was smooth. In two of the 20 dissected joints, the cartilage was fibrillated and eroded. These were graded as slight osteoarthritic changes. Marked osteoarthritic changes were not seen in any specimens. The PTFJ can be a good source of osteochondral autograft to treat cartilage lesions with less morbidity.16,17

Secondary degenerative changes may complicate an instable joint and aggravate the symptoms of lateral knee pain. Radiological findings included osteophytes over both the fibular and tibial side of the joint, together with narrowing of joint space.18

**Ganglion**

A ganglion is a benign cystic mass with a dense fibrous connective tissue capsule which contains clear high viscosity mucinous fluid. It is thought to be the result of myxoid degeneration. Ganglion cysts originating from the PTFJ is uncommon, with a reported prevalence of 0.76%.19,20

Location of the PTFJ ganglions varies widely. They may remain subcutaneous or may spread into peroneal muscles and adjacent bony structures. It may develop along the terminal branches of the common peroneal nerve either outside or within the nerve and cause motor or sensory deficits.

Either ultrasonography or MRI can be the imaging choice to confirm the diagnosis.21 Marginal excision is the surgical treatment of choice. For recurrent cases, treatment by resection arthroplasty or PTFJ fusion has been reported.22,23

**Synovial cyst**

Synovial cysts may be formed by increases in intraarticular pressure, perhaps due to active synovitis or joint injury, causing an outpouching of the joint capsule which then herniates.24 Synovial cysts 

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**Figure 1.** (A) Segmental fractures of the tibia and fibula with dislocation of the proximal tibiofibular joint; (B) open reduction and screw fixation of the proximal tibiofibular joint; and (C, D) after removal of the screw, the proximal tibiofibular joint remained reduced.
cysts arising from the proximal tibiofibular joint may result in a slowly expanding focal mass just distal to the fibular head. Compression neuropathy of the common peroneal nerve may occur.

The cysts are recognized on MRI as a homogeneous fusiform fluid collection with a communicating neck leading from the cyst into the PTFJ.26 Surgical intervention is indicated in patients with nerve palsy. Complete excision with its stalk is the treatment of choice.24–26

Synostosis

Proximal tibiofibular synostosis is usually associated with a known generalized disease such as multiple hereditary exostosis. O’Dwyer27 classified proximal tibiofibular synostosis into three radiologic types. Type 1 represents a straight fibula with a large synostosis arising from the proximal to the middle and distal thirds of the tibia and fibula, assumed to be caused by a trauma. Type 2 represents a synostosis at the level of the proximal tibiofibular joint with a normal fibular length and a mild bowing in the proximal fibula (Figure 2). Type 3 represents a more distal synostosis than Type 2 with a marked bowing of the fibula (and widening of the interosseous distance) throughout its length.27 Most of the anomalies were congenital or occurred before closure of the growth plate. There were associated deformities such as distal positioning of the PTFJ, bowing of fibula, or valgus deformity of the knee. Takai et al28 proposed that the classification of O’Dwyer27 should be extended with a Type-4 synostosis, which occurred after closure of the growth plate. Repeated mechanical stress to the PTFJ due to ankle dorsiflexion is a possible cause. There is no deformity, bowing, or length discrepancy of the fibula in the case reported.28 Lateral knee and ankle pain are the most common presenting symptoms. Van Ooij et al29 reported a patient presenting with persistent low back pain and referred pain in right leg. Diagnosis was made with radiographs and computed tomography whereas MRI ruled out any pathology at the lumbar spine. Excision of the synostosis was performed with an additional peroneal nerve release. Postoperatively, the pain at the level of the tibiofibular joint decreased, and the low back pain symptoms and referred pain disappeared entirely.

Pigmented villonodular synovitis

Pigmented villonodular synovitis (PVNS) is a disorder of unknown aetiology which can affect joints, tendon sheaths, and bursae. The articular form generally involves the knee joint in isolation and causes synovial proliferation and haemosiderin deposition. The common presentation is a painful swollen joint. It rarely involves the PTFJ (Figure 3) and was reported by Ryan et al30 and Lui.31

Synovial chondromatosis

Synovial chondromatosis is a condition characterized by the formation of multiple metaphysic foci of cartilage within the intimal layer of the synovial membrane of the diarthrodial joint. In addition, multiple cartilaginous loose bodies are observed when the metaphysic foci become pedunculated and detached.

Bozkurt et al32 present a case of synovial chondromatosis of the three compartments of the knee joint together with the proximal tibiofibular joint. The patient underwent total synovectomy along with knee arthroplasty due to her prolonged symptoms and severe arthritic changes in the knee joint.

Treatment

All patients with PTFJ subluxation may initially be treated with cast immobilization for 2–3 weeks.15 Other nonoperative options for patients with chronic instability include modifications of a patient’s activity level and training programs, utilization of a supportive strap placed 1cm below fibular head, and lower leg strengthening.4

Idiopathic subluxation in young patients should probably not be treated surgically as this appears to be a self-limiting condition.15 Surgery may be indicated in patients with evidence of peroneal nerve palsy or persistent pain, sense of instability, secondary osteoarthritis who failed conservative treatment.7 Traditional options are arthrodesis of the PTFJ or resection of fibular head.

PTFJ arthrodesis may be performed with bone graft or screw fixation. It may be complicated by stress fracture of the screw, significant pain and instability of the ankle.4,15 Ogden15 recommended resection of fibular head. The styloid process and fibular collateral ligament should be left intact if possible. The collateral ligament should be reinforced by suturing to underlying tibial periosteum. However, resection of the fibular head may disrupt the posterolateral corner structures of the knee joint.5

van den Bekerom et al33 performed a temporary screw fixation of the proximal tibiofibular joint (Figure 4) for 3–6 months and a release of the peroneal nerve. In general, the results in their series
(>10 athletes) are good. The advantage of this technique is that it is much less invasive and less extensive and requires only a minimal incision. Screw removal reduced pain and instability of the ankle joint due to PTFJ arthrodesis.

PTFJ ligaments reconstruction has been advocated in recent years. Yaniv et al.18 described a procedure which addressed both the instability and the joint secondary arthritis. Stability of the joint is achieved by ligament reconstruction using a biceps femoris split passed through the tibial metaphysis and fixated back to the tibial head using bone anchors. The arthritic changes are addressed by interposition of a vascularized fascia lata strip.

Anatomic reconstruction technique for chronic anterolateral proximal tibiofibular instability utilizing an autogenous semitendinosus tendon was presented by Horst and LaPrade.34 There were two patients with posterior proximal tibiofibular ligament disruption leading to anterolateral fibular subluxation that was eliminated by an anatomic ligamentous reconstruction. Both patients returned to normal activity, with satisfactory knee function and improved IKDC subjective knee and Cincinnati Knee Survey scores after 2-year follow up.

**Proximal tibiofibular joint arthroscopy**

Lui31 has developed the technique of proximal tibiofibular joint arthroscopy (Figure 5). Both the joint and the adjacent capsulo-ligamentous structures can be accessed through the proximal anterior and posterior portals. The primary working area is the potential space just above the PTFJ which is deep to the lateral collateral ligament and anterior to the biceps femoris tendon. The peroneal nerve is protected by the biceps femoris. After resection of the fatty tissue of the potential space, the lateral collateral ligament, the biceps femoris tendon and the popliteofibular ligament can be identified. The posterolateral corner of the knee can also be reached through the proximal posterior portal. The anterior and posterior proximal tibiofibular ligaments can be identified at the anterior and posterior gutters of the joint, respectively. The articular cartilage can be approached by resection of the capsule of the proximal tibiofibular joint with preservation of the ligaments. The described technique is essentially an endoscopic approach to the joint. A truly arthroscopic approach to this joint is very difficult if not impossible because of the tight joint capsule.

Proximal tibiofibular arthroscopy was a feasible alternative to the open approaches. It allows access to the joint and adjacent important ligamentous structures. This may form the basis of further development of arthroscopic procedures of the joint and reconstruction of adjacent capsulo-ligamentous structure. Besides arthroscopic synovectomy, other potential applications of this arthroscopic approach include arthroscopic assisted open reduction and internal fixation of an acutely dislocated or subluxed joint; arthroscopic ganglionectomy; arthroscopic arthrodesis; and arthroscopic resection of the fibular head.
Summary

The proximal tibiofibular joint is a frequently neglected joint which can be a source of lateral knee pain. Open surgery is the current mainstay of surgical management of proximal tibiofibular joint disorders. The proximal tibiofibular arthroscopy allows access to the joint and adjacent important ligamentous structures. This forms the basis of further development of arthroscopic procedures for a variety of pathologies.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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