Chapter 20
Peroneal and Posterior Tibial Tendon Pathology

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Success is no accident.
It is hard work, perseverance, learning, studying, sacrifice
and most of all, love of what you are doing or learning to do.

Pele

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Abstract Football is a demanding sport requiring specific repetitive technical gestures involving the foot and ankle. This must be taken into account in the understanding of complaints, the search for diagnostics, and the selection of the appropriate action. Patient's expectations usually include full recovery with fast return to previous activity level. Overuse and post-trauma events (isolated or in association) are the most frequent etiologic factors of tendon-related problems. The goal of this chapter is to present an overview of peroneal tendons (evertors) and posterior tibial tendon (invertor) pathologies in football. The therapeutic options herein discuss the aim to reflect the requirements of football players in their active period. Complementary data including a broad analysis of ankle anatomy, biomechanics, physiopathology, and treatment including a complete surgical manual can be found on http://www.ankleplatform.com.

Keywords Groove deepening • Peroneal tendons • Posterior tibial tendon • Tendinopathy • Tendon rupture • Tendoscopy • Tenosynovitis

20.1 Introduction

Ball control during practice of football is far from being a simple achievement. Enhanced proprioception and fine-tuned neuromuscular control during all foot and ankle positions are required and demand training strategies [3].

The balance between pronation and supination is mandatory for normal gait but even more solicited during football (e.g., ball reception or dribbling). It mostly depends on adjustments of the subtalar joint, but the ankle joint and foot participate at different levels. Foot pronation is a complex movement which combines abduction of the forefoot, eversion of the hindfoot, and dorsiflexion [8]. Supination also occurs in three planes while combining internal ankle rotation, hindfoot adduction, forefoot inversion, and medial arch elevation. Pronation provides some degree of flexibility opposing to supination which is associated to increased foot stability [3]. The invertors of the foot comprise posterior and anterior tibial muscles [24]. Conversely, peroneal muscles (PMs), including peroneus longus, brevis, and tertius, are the active evertors of the foot [35]. These muscles play a key role in controlling pronation-supination.

Understanding the biomechanics of the foot and ankle is mandatory in understanding physiopathology. The navicular bone is the "key bone" providing distal support to the talus. In standing position, it represents the higher structure of the longitudinal medial arch. The harmony of these structures in static position relies on the surrounding bones and the spring ligament (calcaneonavicular). In motion, the action of the posterior tibial muscle (PTM) maintains the superior position of the navicular supporting the medial arch. Thus, a weak PTM or diseased posterior tibial tendon (PTT) is unable to keep the navicular in place and a fall of the medial arch might occur (acquired flat foot condition) [17]. Conversely, hindfoot varus or ankle instability creates increased persistent/repeated strain on the peroneal tendons (PTs) which will predispose to pathology [35]. These basic examples are representative of the paramount relevance of biomechanical phenomena in this field.

In the light of the previously exposed, some therapeutic options implicate a surgical modification of this complex biomechanics (e.g., tendon transfers, osteotomies, or fusion of selected joints). Such procedures have been proposed through time with strict selection criteria and usually addressing the general population and not high-level athletes [16, 30, 41]. They are considered out of the scope of this text and are properly described elsewhere (http://www.ankleplatform.com). Dealing with patient's expectations is mandatory. Implications of surgical options on function, including sports-specific skills, must be considered on an individual basis.

History taking and physical examination including gait analysis are the first and most important step in the diagnostic process. In some cases, evaluation on the pitch during football practice can be useful. History of medication consumption must be addressed once some (e.g., fluoroquinolones – FQs) have been recognized as risk factors for tendinopathies. FQs should indeed be used cautiously in athletes [14].

Radiological study must always include standing foot and ankle x-rays. Ultrasound and MRI might be useful (Fig. 20.1); however, limitations exist and must be acknowledged. Ultrasound is known to be operator dependent while providing dynamic evaluation [20]. MRI is considered diagnostically specific but not sensitive [26]. It has presented fair sensitivity for diagnosing chronic peroneus

Fig. 20.1 MRI showing peroneus brevis tendinopathy (*yellow arrow*). Notice flattening of the ruptured tendon surrounding peroneus longus and increased fluid within the synovial sheath surrounding both tendons

longus pathology, but not in the peroneus brevis [26, 34]. Similar limitations have been described for PTT [48]. Local anesthetic injection can be considered to confirm the origin of pain [2]. CT scans are particularly useful in the study of bony structures which might be suspected (e.g., prominent peroneal tubercle, navicular deformities, bone ossicles/spurs). Endoscopic/tendoscopic evaluation provides direct inspection and is gaining popularity in either diagnostic or therapeutic approaches [26, 48].

Morphological constitutional conditions can sometimes be favorably overcome with adapted shoes, insoles, or orthoses when it brings athlete's comfort without negative implication in skills ([15], see also book Chap. 21).

One needs to listen and identify properly the nature of the complaints. The goals are as follows: identify its etiology, understand how it affects the patient (in his/her specific needs), and try to find a therapeutic option which might provide relief while being compatible to football participation at the same level. These are the "golden rules." Sometimes, the surgeon might consider an option which suits demands on general population might even provide more "anatomic" outcome but can endanger the short career of a professional football player. All this information must be shared with patients. In selected cases, patients might choose partial or temporary relief of complaints with delay of more "aggressive" approaches.

Herein will be discussed the fundamentals of the most common pathological conditions of PTs and PTT while considering the usual author's approach when dealing with these conditions within this specific group of patients.

20.2 Peroneal Tendons Pathology

As previously stated, the three muscles that evert the ankle are the peroneus longus, brevis, and tertius. The peroneus longus (PL) arises from the proximal fibula, while the peroneus brevis (PB) arises from the distal fibula. The deep peroneal nerve passes under the upper end of the PL.

At the level of the ankle, the peroneus longus tendon (PLT) and peroneus brevis tendon (PBT) pass behind the lateral malleolus and beneath the peroneal retinaculum. PLT runs behind and PBT in front of it. PBT inserts on the base of the fifth metatarsal. PLT runs around the cuboid bone, and along a deeply placed fibrous tunnel, to insert on the base of the first metatarsal.

The PTs receive their nutritive irrigation from vincula supplied by posterior peroneal and medial tarsal arteries. However, three relatively hypovascular zones have been described and considered when dealing with degenerative changes: one in PBT as it surrounds the malleolus and two in PLT (as it curves the malleolus also and when it surrounds the cuboid) [27].

In front of PBT and PLT, there is the peroneus tertius. The peroneus tertius also arises from the fibula. The tendon of peroneus tertius passes under the extensor retinaculum and in front of the lateral malleolus to insert on the base of the fifth metatarsal, next to PBT. It is absent in nearly 10 % of subjects but has been implicated in cases of anterolateral pain and/or “snapping ankle” [13]. Peroneus quartus is a rare anatomic variant. The consequences of a peroneus quartus tendon are unknown. In case of pain or snapping at this level without further pathology, resection can be considered. A prominent peroneal tubercle is another anatomic variant which has been implicated in persistent lateral pain.

The main action of all three of the peroneal muscles is to evert the foot. The PL locks the transversal arch and plantarflexes the first ray [35].

Os peroneum can be found within the length of PLT at the level of calcaneocuboid joint. It has been described in 5–26 % of people and sometimes associated with lateral pain [37]. When observed, a proximal migration of this bony or cartilaginous structure suggests PLT rupture.

All peroneal muscles assist in dorsiflexion of the ankle. We reinforce the relevance of all muscles participating in inversion-eversion once they enable us to stay balanced and upright on an uneven or unstable surface.

20.2.1 Peroneal Tendinopathy

The term “tendinopathy” generally describes a disease of a tendon with complaint of pain and swelling. More specifically, it can refer to terms that were used in the past but are now obsolete [46].

- Tendinitis: tendon injuries which involve predominantly acute injuries accompanied by inflammation.
- Tendinosis: chronic tendon injury with damage to a tendon at a cellular level.
- When it involves a synovial sheath covering, a tendon is then called tenosynovitis.

When there is no synovial envelope but instead a paratenon-covered tendon (e.g., Achilles tendon), then pathological changes are referred as “paratendinopathy” (acute or chronic) [46].

In football athletes, most tendon-related problems are associated to overuse [34]. Traumatic events (contusions, sprains, fractures) are the second leading cause, but morphological foot/ankle issues and football-specific gestures must also be taken into account. It is always mandatory – in the presence of lateral foot and ankle pain on a football player – to rule out concomitant ankle instability.

Clinical examination will show tenderness on palpation, local edema, and intensification of symptoms on active eversion against resistance.

The first option in treatment is conservative treatment: rest, ice, massage therapy, eccentric exercise, NSAIDs, ultrasound therapy, LIPUS, electrotherapy, taping, glyceryl trinitrate patches, last-generation extracorporeal shockwave therapy (ESWT), insoles, and shoe changes.

If conservative treatment fails, one can consider peroneal tendoscopy [43]. This approach permits confirmation of uncertain findings after imaging study including dynamic evaluation, treatment of hypertrophic tendinopathy, minimally invasive

Fig. 20.2 Two needles point proximal (2–2.5 cm) and (1.5–2.0 cm) distal portals using lateral malleolus as superficial landmarks (**a**). Notice that the little finger of the surgeon's left hand is slightly supported in the patient facilitating small motion control (**b**). Postoperative look after closure of the wounds (**c**)

cleaning of synovitis, removal of debris and inflammatory fluid, or regularization of prominent peroneal tubercle [33]. In properly selected cases, particularly in elite football players, it "breaks" the vicious circle associated to repetition of complaints after football gameplay (Figs. 20.2 and 20.3).

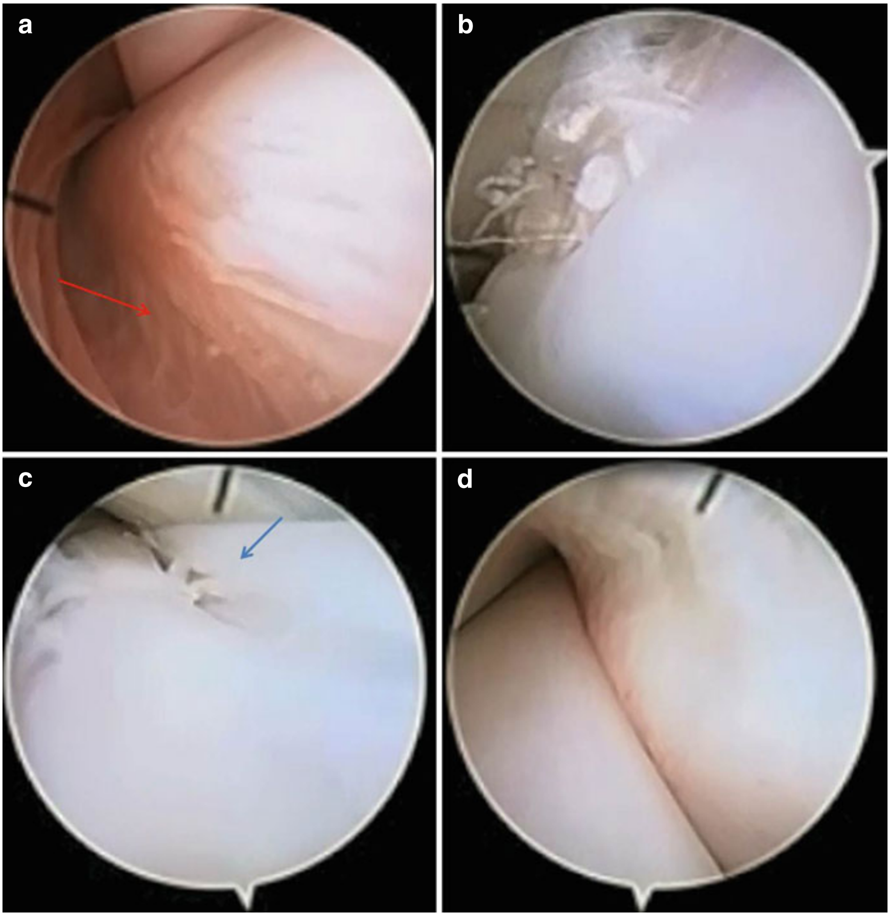

Fig. 20.3 Peroneal tendoscopy showing both tendons and vincula (*red arrow* – **a**); rupture of peroneus brevis noticed (**b**); further inspection revealed a length rupture (*blue arrow* – **c**); notice the flattened aspect of the tendon on the right surrounding the tendon on the left bottom of the image (**d**) similarly to what was suggested in MRI of Fig. 20.1

Compared to open surgery, tendoscopy presents several advantages: lower aggression (minimizing scar tissue), lower morbidity, reduction in postoperative pain, functional aftertreatment, and outpatient surgery.

20.2.1.1 Peroneal Tendoscopy Technique (Figs. 20.2 and 20.3)

The patient lies supine with a beanbag under the buttock to help endorotate the foot or in lateral decubitus. A bloodless field is used. Two main portals are located directly over the peroneal tendons. One portal is created 1.5–2 cm distal and

2–2.5 cm proximal to the posterior edge of the lateral malleolus. The distal portal is made first. A skin-only incision is made and then the tendon sheath is opened using a blunt trocar within the scope's sleeve.

The 30° 2.7-mm arthroscope (or sometimes 4.5 mm) can be used according to patient profile, availability, and personal experience. It is possible to use 1.8-mm scope; however, it must be considered as a general rule that the smaller the tools, the more "aggressive"/sharp it tends to be comparing to relative bluntness of larger devices. Furthermore, it provides more limited visualization capacity and fluid supply. We recommend keeping the fifth finger supported while controlling the arthroscope with the remaining four for fine control.

Postoperative treatment consists of dressings with partial weight-bearing for 2–3 days. Active motion is encouraged from the first day.

20.2.2 Peroneal Tendon Ruptures

Peroneal tendons have been misdiagnosed during several years [40]. Peroneal tears might result from acute trauma, associated to ankle instability and retinaculum insufficiency with or without subluxation. A cavovarus foot produces increased strain on lateral structures. A plantarflexed first ray must be ruled out opposing to calcaneus varus by means of clinical examination including the Coleman block test [9].

Peroneal ruptures have been described as "Zone I" (proximal injuries usually involving PBT) or "Zone II" (distal injuries involving PLT pathology sometimes associated to *os peroneum*) [38].

Patients complain of lateral pain and swelling, many times following an inversion injury. Sometimes the feeling of a "pop" and subsequent ankle weakness is described.

Radiographies should search for small ossicles, avulsions, or *os peroneum* changes. US and MRI (Fig. 20.1) might help. As previously stated, local anesthetic injections can confirm the origin of complaints.

Conservative treatment includes medication, physiotherapy, bracing, orthoses, or temporary immobilization. However, particularly in high-level footballers, this might fail on the long term.

The author's preferred surgical approach is the tendoscopy one. Besides confirming the diagnosis with dynamic and precise knowledge of the characteristics of the injury, it might permit definitive treatment of some partial tears. Furthermore, it helps on determining the precise location of injuries, thus helping to minimize the surgical aggression if open surgery is required. Basic principles of the technique were formerly described.

20.2.2.1 Peroneal Tendons Open-Surgery Technique

The position of the patient can usually be the same following tendoscopy. A limited lateral incision is performed according to the previously determined (tendoscopy)

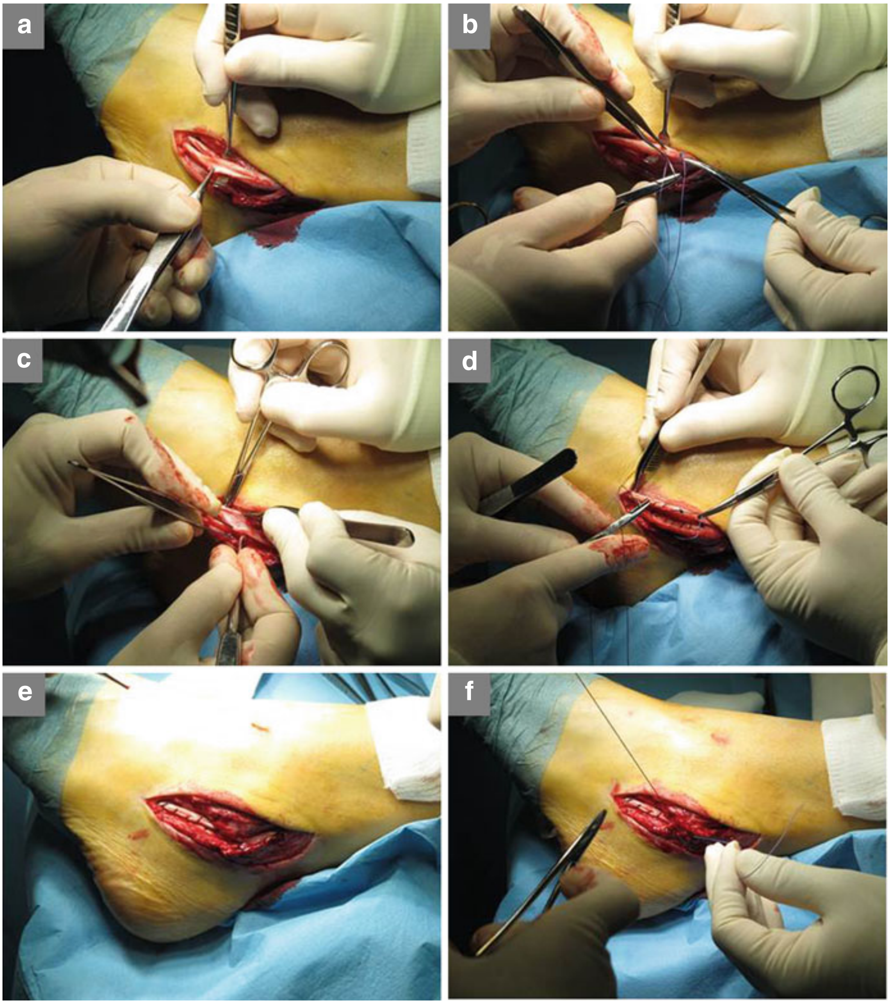

Fig. 20.4 Peroneus brevis length rupture exposed (**a**), tubularization suture of PBT (**b**), concomitant peroneus longus length rupture (**c**), repair of PLT using the same method (**d**), dynamic inspection of both tendons in place (**e**), closure of peroneal retinaculum (**f**)

injury position or need to approach the peroneal retinaculum. The common peroneal sheath is opened and both tendons inspected as well as concomitant bony structures (Fig. 20.4).

If a degenerated portion of the tendon is detected, it should be excised. A low-riding muscle belly can be excised. In case of a clear length rupture, direct repair is possible. Tubularization repair is performed in case of flattening of the tendon using absorbable sutures (Fig. 20.4). Closure is performed by planes with re-tensioning of the retinaculum when appropriate.

Postoperative care includes Walker boot immobilization with protected partial weight-bearing for 4–6 weeks. Full weight-bearing follows. Closed-chain exercises with heel support are permitted if pain and swelling disappear at the same period. Protected ankle range of motion exercises are permitted 3–4 weeks.

Several authors recommend tenodesis when more than 50 % of tendon thickness or more than 2-cm length is affected; however, this represents a higher aggression to consider carefully on an active soccer player [9]. If tendons are found to be irreparable, tendon grafts (e.g., plantaris tendon) or transfers (e.g., flexor hallucis longus tendon) might also constitute valuable options. If the *os peroneum* needs to be removed, a tenodesis of PLT to PBT is required [9]. Selected cases might benefit from bony procedures (e.g., osteotomies); however, this subject is considered out of the scope of this chapter.

20.2.3 Peroneal Tendons Dislocation

Peroneal tendon instability was first described in the early nineteenth century in a ballet dancer [19]. A peroneal tendon dislocation is a rare event which often occurs after a single traumatic event which creates a sudden resisted contraction of the peroneal muscles [32]. Most frequently the foot is dorsiflexed, abducted, and everted but has also been described during forced dorsiflexion while the foot is everted [22]. Usually, this condition happens during sports participations (football, ski, American football, running, gymnastics, tennis, ballet, basketball, or ice skating) [32]. The superior peroneal retinaculum (SPR) is the primary restraint to PTs dislocation; however, recurrent dislocation correlates with the groove depth [23]. Eckert and Davis described that the superior retinaculum and the periosteum insertion can be detached from the fibula [4]. They described a classification in which grade I represents detachment of SPR from the collagenous lip; in grade II, both structures are separated from the fibula; and in grade III, a small bony avulsion accompanies the detachment of both previous structures. A grade IV was added later, describing a retinaculum rupture from its posterior attachment [23]. In general, grade I comprises more than 50 % of all cases.

When a dislocation occurs, this predisposes to recurrence. Furthermore, it has been shown that lateral ankle ligament laxity increases the strain transmitted to the retinaculum which explains the association between both conditions [7]. Differential diagnosis with "snapping ankle" caused for peroneus tertius is required. Several anatomic variants (tendinous or bony), concomitant ankle instability, or varus malalignment predisposes to this condition.

Conservative treatment (physiotherapy, bracing, taping, orthoses, immobilization) has been associated to a high recurrence rate [22] opposing to excellent results reported with surgical treatment [32]. Several procedures have been described either directed to repair or reinforcement of the SPR or bony procedures aiming groove deepening (including bone-block procedures) [28].

There is a lack for large controlled series comparing results of several techniques. It is therefore not possible to claim superiority of any technique over another concerning re-dislocation rate.

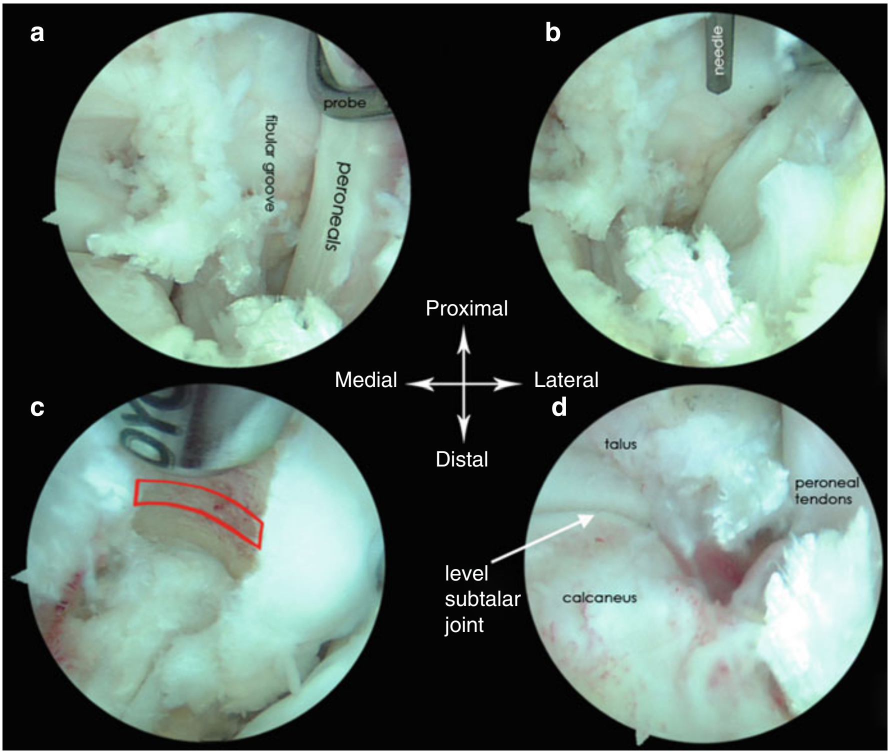

Fig. 20.5 A probe is used to remove the peroneals from their native grove (**a**). A needle assists in the correct placement of accessory portal (**b**). A 5-mm shaver is used to deepen the groove (*red rectangle*) (**c**). Final result with peroneals in place (**d**)

Considering a football population, the author's preferred technique (Fig. 20.5) comprises endoscopic groove deepening [32, 50]. Despite reported excellent results, it constitutes outpatient surgery and enables functional treatment from day 1 enabling a faster rehabilitation. Open surgery comprises a higher risk of complications (sural nerve injury, secondary scar, and infection) [31]. Moreover, a plaster cast is indicated after an open procedure which delays the rehabilitation process.

20.2.3.1 Technique for Endoscopic Peroneal Tendon Groove Deepening

The patient is placed prone as described for posterior ankle arthroscopy [45]. The tendons are inspected after opening the peroneal tendon sheath (Fig. 20.5). A probe is used to dislocate both tendons from the groove. An accessory portal is created to introduce a 5-mm bone-cutter blade to deepen the groove. Tendons are then relocated within the groove by removing the probe. The patient is discharged in the same day. Immediate weight-bearing is permitted as tolerated as well as activities of daily living. An ankle brace is applied during 6 weeks.

20.3 Posterior Tibial Tendon Pathology

The tibialis posterior muscle arises from the back of the tibia, the back of the fibula, and the interosseous membrane. PTT passes immediately behind the medial malleolus, through a fibrous tunnel which is covered by the flexor retinaculum. Beyond the malleolus, the tendon begins to fan out. It has a wide insertion including the navicular and first cuneiform bones and the bases of the second, third, and fourth metatarsals. The PTT does not have a mesotenon.

Immediately distal to the medial malleolus, it has an area with poorer vascularity which can be implicated in degenerative changes of the tendon [6]. The PTT is an important dynamic stabilizer of the medial arch and the most powerful invertor of the foot [8].

A patient suffering from PTT tendinopathy might refer posteromedial ankle pain alone. However, on clinical examination, one can find local tenderness, a positive PPT provocation test, and inability to walk on tiptoes. Radiographies assess global foot and ankle morphology. MRI and US – despite their known limitations – are useful to identify pathologies, such as tenosynovitis, (longitudinal) ruptures, degenerative changes, or adherences [2, 17].

Johnson and Strom proposed a classification system correlating the severity of PTT dysfunction and subsequent adaptations of the foot (to the collapse of the medial longitudinal arch) along with combined treatment recommendations [12]. Considering the football player, only grade I dysfunction will be herein considered. This includes PTT tendinopathies without major deformity.

Conservative treatment comprises physiotherapy, medication, insoles, and corrective shoes (medial heel and sole wedge). However, when it fails overtime, with limited function, particularly on an athletic population, the author's option is once more tendoscopy.

Indications for posterior tibial tendon tendoscopy [44]:

- Tenosynovectomy
- Tendon sheath release
- Tendon debridement and cleaning of partial rupture
- Resection of pathological vincula
- Removal of exostosis/irregularity of posterior tibial sliding channel
- Endoscopic removal of implants (screws/anchors) from medial malleolus
- Adhesiolysis
- Diagnostic procedure

Posterior tibial tendoscopy enables diagnostic confirmation for patients with a suspected or radiologically diagnosed partial tendon tear (once either false positives and false negatives have been described) [48]. Partial tendon tears can be diagnosed and treated while avoiding a large incision, increased postoperative pain, and prolonged rehabilitation. When a tendon tear suitable for reconstruction is identified, the tendoscopic procedure can be converted to a mini-open approach, which is still less invasive than the standard open procedure.

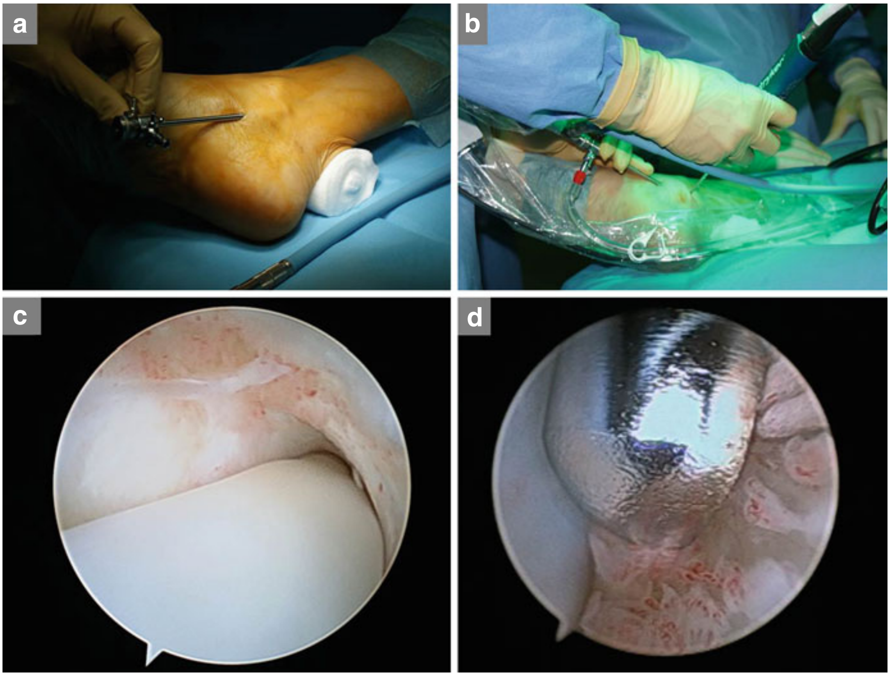

Fig. 20.6 Creation of the distal portal 2.5 cm distal to the posterior edge of medial malleolus (**a**), use of 2.7-mm shaver from proximal portal (**b**), inspection of all the tendon sheath surrounding the tendon with the arthroscope (**c**), cleaning of tenosynovitis using the shaver blade (**d**)

20.3.1 Technique for Posterior Tibial Tendoscopy

The patient is positioned supine and a bloodless field used. For superficial landmarks, the patient is asked before anesthesia to actively invert the foot, to facilitate palpating the PTT to mark the portals. The level of maximum pain should also be marked. The distal portal (Fig. 20.6) is performed first, 2.5 cm distal to the posterior edge of the medial malleolus. A 30º 2.7-mm arthroscope is introduced, and the complete tendon sheath should be inspected. The proximal portal is made under direct vision using a needle, after which an incision is created in the tendon sheath and a 2.7-mm shaver can be used. At the end of the procedure, the portals are sutured, and a bandage is applied. Active range of motion exercises are performed from day 1. Partial weight-bearing is advised for 2–3 days and gradually resumption of daily activities as supported. Sutures are removed from the 10th to 14th days.

20.4 Anterior Tibial Tendon

The tibialis anterior acts as an ankle dorsiflexor. Tibialis anterior tendinitis is rare. However, a direct trauma in a footballer might produce local tenderness and swelling.

Insertional tendinopathy has been described, more often in ballet dancers or jumpers. Patients describe pain on the medial cuneiform particularly when loading the foot immediately after heel strike or during swing phase of gait [29]. Spontaneous rupture is also rare and usually occurs in elderly people causing a foot drop and subsequent gait abnormality.

20.5 Injection Therapy

Percutaneous treatment of pain conditions has been gaining increased popularity, particularly among football players.

Injection treatments have been including several agents such as corticosteroids [11], polidocanol, platelet-rich plasma (PRP), high-volume injections, hyperosmolar dextrose, brisement, aprotinin, and low-dose heparin [49].

Corticosteroids have a powerful anti-inflammatory effect. Its use in tendon pathology is currently discouraged given the risk of subsequent tendon degeneration and/or rupture [39].

Polidocanol has been proposed as a method to abolish neovascularity within and around inflamed tendons [21]. However, the role of this neovascularization phenomenon is not fully understood which is in line with inconsistent results obtained from the method [47].

One must understand that each agent and technique presents its specific implications, and until now there is no such thing as a securely effective and harmless percutaneous “panacea” capable to cure all sources of pain.

There is controversial data in literature involving percutaneous treatment/prolotherapy, and sometimes the rationale supporting its application, particularly in tendons, is not completely understood.

These are promising and increasingly developing techniques and, while considering them as valuable options in specific conditions, one should keep some caution and critical spirit.

Currently, the most popular is probably PRP in one of its different preparations (with inherent different effects). It has been promoted for injection therapy as minimally invasive, nonoperative approach for several conditions [25]. It proposes a wide range of favorable defects in several tissues including tendon pathologies, muscle injuries, or even cartilage and joint arthritis. However, there has been some controversy on its clinical use [42]. Results have been obtained from pathologies, considering different tissues and different preparations of PRP (e.g., with/without leukocytes, platelet concentration, etc.) which limits the possibility for further conclusions or guidelines for its application [18]. It should be acknowledged that this is a promising technique. Growth factors provide consistent laboratorial results; however, extrapolation to clinical setting is demanding [1]. Improved methodology in related research design and more clinical trials assessing outcome of PRP technology are still required [5].

It is necessary to develop appropriate guidelines and increase evidence level prior to its widespread application as a treatment option for joint diseases [36].

Many limitations persist concerning clinical and basic science aspects of tendon healing. The critical goal is tendon repair that leads to faster rehabilitation with regeneration of tissue with similar or better characteristics than those of the normal tendon. Tissue engineering and regenerative medicine research envisions new answers for the future [10].

20.6 Conclusions

Tendinopathies around the foot and ankle in footballers are frequently associated to overuse and/or traumatic events. Fine control of pronation-supination has been implicated in technical skills required for ball control. Dealing with patient's expectations is particularly demanding in elite football players. Tendoscopy of posterior tibial tendon and peroneal tendons has been significantly developed in recent years. It has shown to provide definitive diagnosis in previously dubious situations, enables definitive therapeutic approach in an important percentage of cases, and assists in diminishing surgical aggression when open surgery is required. Despite being a demanding approach with challenging learning curve, it provides shorter recovery with faster return to football participation in selected cases. Future developments from biology and tissue engineering might further improve our course of action. Peroneal tendons and posterior tibial tendon pathologies must be understood combining a comprehensive approach of foot and ankle anatomy and biomechanics.

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