EFORT open reviews

Peroneal tendon disorders

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■ Pathological abnormality of the peroneal tendons is an under-appreciated source of lateral hindfoot pain and dysfunction that can be difficult to distinguish from lateral ankle ligament injuries.

■ Enclosed within the lateral compartment of the leg, the peroneal tendons are the primary evertors of the foot and function as lateral ankle stabilisers.

■ Pathology of the tendons falls into three broad categories: tendinitis and tenosynovitis, tendon subluxation and dislocation, and tendon splits and tears. These can be associated with ankle instability, hindfoot deformity and anomalous anatomy such as a low lying peroneus brevis or peroneus quartus.

■ A thorough clinical examination should include an assessment of foot type (cavus or planovalgus), palpation of the peronei in the retromalleolar groove on resisted ankle dorsiflexion and eversion as well as testing of lateral ankle ligaments.

■ Imaging including radiographs, ultrasound and MRI will help determine the diagnosis. Treatment recommendations for these disorders are primarily based on case series and expert opinion.

■ The aim of this review is to summarise the current understanding of the anatomy and diagnostic evaluation of the peroneal tendons, and to present both conservative and operative management options of peroneal tendon lesions.
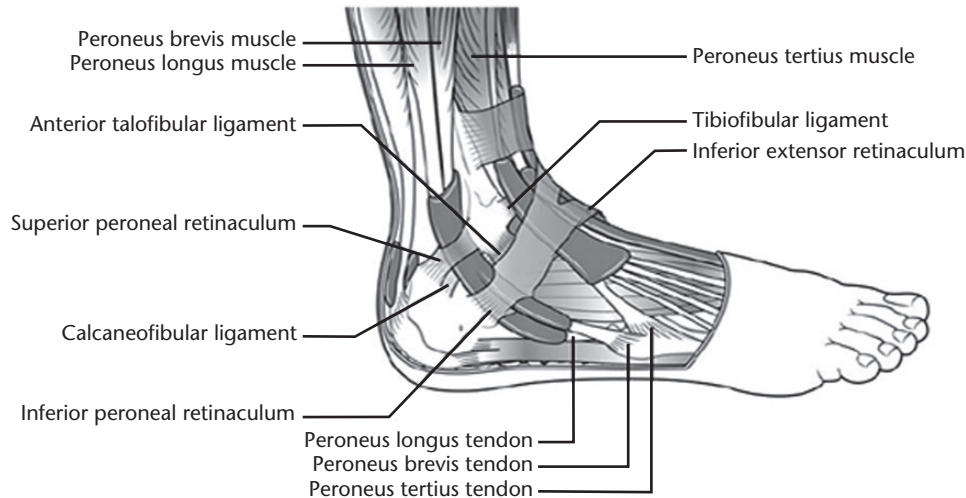
Introduction

Pathological abnormality of the peroneal tendons is an under-appreciated source of lateral hindfoot pain and dysfunction that can be difficult to distinguish from lateral ankle ligament injuries. In a study by Dombek et al,[1] only 60% of 40 peroneal tendon disorders were accurately diagnosed at the first clinical evaluation. Pathology of the tendons falls into three broad categories: tendinopathy, tendon subluxation and dislocation, and tendon splits and tears.[2] These pathologies are frequently encountered in patients with chronic lateral ankle instability or cavovarus hindfoot alignment, and usually result from prolonged, repetitive athletic activities or ankle inversion injuries. The management of these conditions is based on case series and retrospective studies. Typically, these conditions respond to non-operative treatment such as physiotherapy, use of non-steroidal anti-inflammatory drugs, and immobilisation. When left untreated, peroneal tendon disorders can lead to persistent lateral ankle pain and substantial functional problems. The aim of this review is to summarise the current understanding of the anatomy and diagnostic evaluation of the peroneal tendons, and to present both conservative and operative management options for peroneal tendon lesions.

Anatomy

The peroneal muscles form the lateral compartment of the lower leg, and both are innervated by the superficial peroneal nerve. The peroneus brevis originates from the distal two-thirds of the fibula and intermuscular septum, becoming tendinous 2 cm to 3 cm proximal to the tip of the fibula. The peroneus longus arises from the proximal two-thirds of the lateral fibula, the intermuscular septum and the lateral condyle of the tibia. The peroneus tertius is distinct to the brevis and longus, lying within the anterior compartment of the leg. It originates from the lower third of the anterior tibia, interosseous membrane and intermuscular septum between it and the brevis posteriorly.

Both the peroneus brevis and longus tendons lie proximally in a common synovial sheath that extends from approximately 4 cm proximal to the tip of the lateral

Peroneus brevis muscle
Peroneus longus muscle

Peroneus tertius muscle

Anterior talofibular ligament

Tibiofibular ligament
Inferior extensor retinaculum

Superior peroneal retinaculum

Calcaneofibular ligament

Inferior peroneal retinaculum

Peroneus longus tendon
Peroneus brevis tendon
Peroneus tertius tendon

Fig. 1 Anatomy of the lateral ankle (reproduced with permission from Bentley G, ed. *The European Surgical Orthopaedics and Traumatology The EFORT Textbook.* Berlin: Springer Publications, 2014).[52]

malleolus, to 1 cm distal to it (Fig. 1). The brevis tendon is relatively flat, running directly posterior to the distal fibula. The peroneus longus is more rounded and lies posterior to the brevis tendon. Both are contained within the retro-malleolar groove, a fibro-osseous tunnel bounded by the superior peroneal retinaculum (SPR), the posterior talofibular ligament, calcaneofibular ligament and posterior inferior tibiofibular ligament (Figs 2a to 2c). The retinaculum is composed of both fascia and a synovial sheath forming a superior and inferior band. These typically span from the distal 2 cm of the fibula to the Achilles tendon and the lateral calcaneum, respectively. The superior band provides the primary restraint to tendon subluxation.[3] The shape of the retromalleolar groove also plays a significant role in maintaining tendon stability and varies between individuals. In a cadaveric study of 178 fibulae, Edwards[4] demonstrated the groove was concave in 82% of subjects, flat in 11% and convex in 7%. It has a mean depth of 2 mm to 4 mm with an average width of 9 mm.[5] The surface area is increased laterally by the non-osseous 'fibrocartilagenous ridge' and medially by the osseous 'retromalleolar groove'.[6]

Below the retromalleolar groove, the two tendons separate and are enclosed in two distinct synovial sheaths. Both cross the lateral calcaneal wall, separated by the peroneal tubercle, where the sheaths thicken and form the inferior extensor retinaculum. The brevis tendon passes above the tubercle to attach to the dorso-lateral surface of the fifth metatarsal base (Fig. 2d). The longus, in contrast, passes below the tubercle to continue into the cuboid tunnel. Hyer et al[7] performed a cadaveric study of 114 calcanei and described three main variations of the peroneal

tubercle: flat (42.7%), prominent (29.1%) and concave (27.2%). Prominence of the tubercle of > 5 mm in height is reported to be related to peroneus longus impingement and stenosing tenosynovitis, as it passes under the inferior retinaculum.[8]
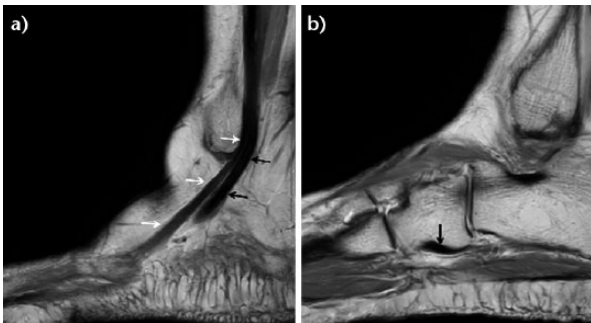
The peroneus longus passes under the cuboid to enter a fibro-osseous tunnel, formed between the long plantar ligament and a groove under the cuboid (Fig. 3). As it continues obliquely along the plantar aspect of the foot, the longus eventually attaches to the plantar proximal surface of the medial cuneiform and the base of the first metatarsal.

Located within the distal fibres of the longus is the os peroneum, an oval or round shaped sesamoid bone, highlighted in Figure 4. Sarrafian[9] suggests the os is predominantly fibrocartilaginous, ossified in 20% of individuals and radiographically apparent in as few as 5%. Its morphology varies and, similar to other sesamoids within the body, it may be uni-, bi- or multi-partite. It may articulate with the lateral calcaneum and either the calcaneo-cuboid joint or inferior cuboid. Painful os peroneum syndrome (POPS) is a term coined by Sobel et al[10] to describe a spectrum of pathology of the os varying from acute fracture to a hypertrophied peroneal tubercle which entraps the peroneus longus tendon and/or the os peroneum during tendon excursion. Figures 5a and 5b demonstrate the MRI changes that are visible in an oedematous os peroneum, when compared with an asymptomatic os as shown in Figure 4.

The peroneal tendons receive their blood supply through vinculae from the posterior peroneal artery and the medial tarsal artery.[11] Petersen et al[12] described three
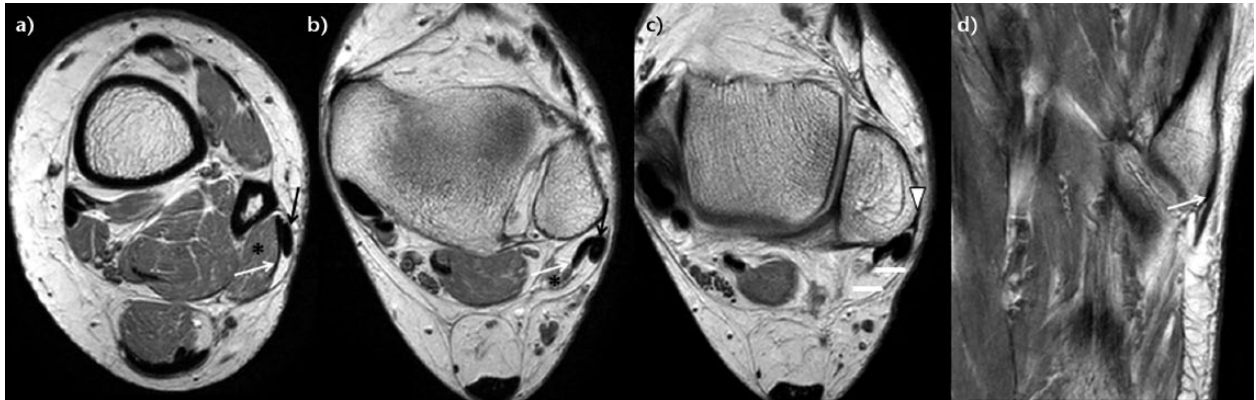
Fig. 2 a-d) Sequential axial proton density (PD) MR images (a – d, superior to inferior). The peroneus brevis muscle (*) has a slender tendon (white arrow) that runs medial to the peroneus longus (black arrow) tendon in the distal calf (a) and maintain this relationship at the ankle (b). At the level of the talar dome (c), the superior peroneal retinaculum (white chevrons) attaches to the retromalleolar fibrocartilagenous ridge (white triangle) at the posterolateral aspect of the lateral malleolus. (d) Peroneus brevis tendon attaching to the base of the fifth metatarsal (white arrow).

Fig. 3 a-b) Sagittal proton density MR images through the lateral aspect of the ankle, showing (a) the peroneus brevis (white arrows) and longus (black arrows) passing posterior to the lateral malleolus and the peroneus longus within the cuboid tunnel (black arrow, b).
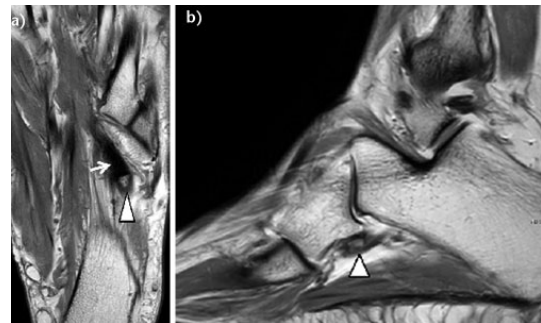
Fig. 4 a-b) Asymptomatic os peroneum. Axial (a) and sagittal (b) proton density MR images show a small focus of ossification (white triangle) in the peroneus longus tendon (white arrow) as it enters the cuboid tunnel. No oedema was visible in the ossicle on fluid sensitive sequences.

avascular zones and suggested these correspond with areas of peroneal tendinopathy. One zone exists in the peroneus brevis as it passes the lateral malleolus; and two further in the peroneus longus as it passes around the lateral malleolus and as it runs under the cuboid. The presence of these zones has been refuted and remains a subject of debate.[11]

Anatomical variations

A low lying peroneus muscle brevis is relatively common, seen in up to 33% of individuals. It is diagnosed when the muscle belly extends below the superior margin of the SPR. However, what constitutes a low lying muscle belly is unclear as the level of the musculotendinous junction is affected by foot position: extension of the muscle into the groove was seen in a group of asymptomatic volunteers with the foot in dorsiflexion and less frequently with the foot plantar flexed.[13] Thus care should be taken not to

misdiagnose this finding as a pathological condition when interpreting MR studies of the ankle; we often corroborate MRI findings with ultrasound imaging in our unit to differentiate it from a peroneus quartus.

The peroneus quartus muscle typically originates from the peroneus brevis muscle belly in the distal one-third of the leg and descends posteromedial to the peroneal tendons. Its site of insertion is variable, most commonly inserting into the retrotrochlear eminence of the calcaneus or occasionally, the base of the fifth metatarsal, the brevis or longus tendon, or the inferior extensor retinaculum and the cuboid bone.[14-16] The presence of the muscle is relatively common, occurring in 6.6% to 21.7% of cadaveric specimens[15,17] and it appears on an ultrasound scan (USS) and MRI as a discrete muscle or tendon structure, separated from the adjacent peroneus muscles by a fat plane (Fig. 6). Both the low lying brevis and quartus anomalies can overcrowd the retromalleolar groove,
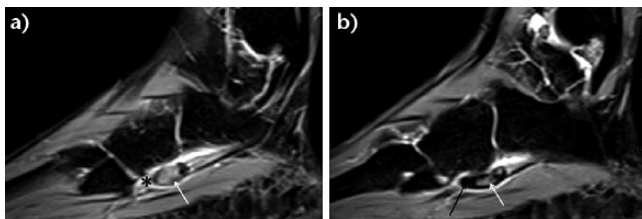
Fig. 5 a-b) Oedematous os peroneum. Sagittal proton density fat suppression MR images lateral (a) and medial (b) showing an oedematous ossicle (white arrow) within the peroneus longus tendon (black arrow in (b)) and surrounding oedema fluid (*).

Fig. 6 Axial proton density MR images demonstrating a peroneus quartus (black arrow) with either a distinct muscle belly (a) or slender tendon (b) posteromedial to peroneus brevis, with a separate and high variable distal insertion.

causing laxity of the SPR and is associated with longitudinal splitting, tenosynovitis and dislocation.[16]

Peroneal function

The peroneus brevis provides 63% of total eversion power, as well as assisting in ankle plantarflexion. Peroneus longus acts to plantarflex the first ray and evert the foot. The tendon also acts at the secondary plantarflexor of the ankle, stabilising the medial column in stance. The rotating effect on the medial column in the frontal plane was demonstrated in a cadaveric study by Johnson and Christensen.[18] The authors suggested the first ray locks at the first tarsometotarsal joint as the longus contracts.

The peronei are the first muscles to contract in response to a sudden ankle inversion stress and thus are vital to controlling the dynamic stability of the lateral ankle complex.[19,20] Delayed activation of the peroneal muscles in response to sudden inversion perturbations has been hypothesised as a cause of functional instability following lateral ankle sprain. There have been several studies which support this hypothesis,[20-22] and several which refute it.[23-25]

Epidemiology

Cadaveric studies suggest the prevalence of peroneus brevis tears is between 11% and 37%, with peroneus longus tears being less frequent. The true incidence in clinical practice is unknown, with a recent retrospective MRI study suggesting peroneal pathology in 35% of asymptomatic cases.[26] Acute peroneal dislocations are misdiagnosed in up to 40% of cases, often mistaken for lateral ankle ligament sprains.[1]

Assessing the foot for alignment and deformity is critical. Brandes and Smith[27] suggested that in patients treated operatively for peroneal tendon tears, the foot was cavovarus in 82% of cases as measured using standardised radiographic parameters. Peroneal entrapment and impingement between the fibular tip and lateral calcaneal wall is also observed in cases of heel valgus (typically secondary to tibialis posterior tendon insufficiency) and post-calcaneal fracture where the heel is widened.
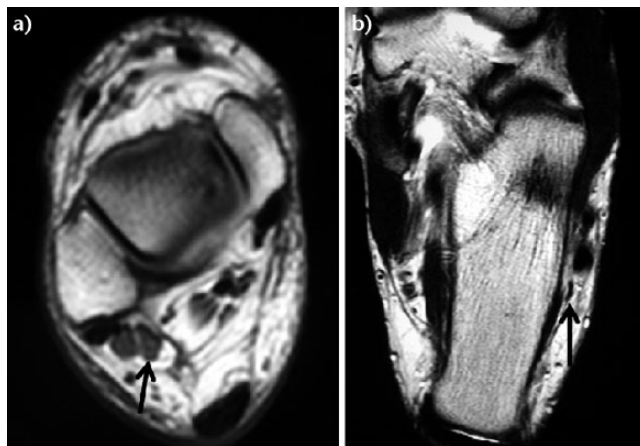
Clinical examination

A thorough history should be taken prior to examination. Before focusing on the lateral side of the ankle, attention should be paid to the overall alignment of the leg and posture of the hindfoot. Patients with hindfoot varus may subject the peroneals to increased forces that predispose to injury, or the varus might result from peroneal weakness. Flexibility and correctability of the varus should be assessed as this may have implications when considering orthotic management. A varus heel might alert the examiner to an underlying neuromuscular disorder such as Charcot Marie Tooth. Note should also be taken of any wasting of the intrinsic muscles, clawing of the lesser toes or a plantar flexed first ray. Patients may also have a non-neurological or subtle pes cavus alignment of the hindfoot. Additionally, lateral ankle ligamentous stability should be checked with the anterior drawer and ankle tilt test. Peroneal disorders often present with swelling posterior to the fibula or along the lateral wall of the calcaneus, with tenderness to palpation along the course of the tendons, pain with resisted eversion, passive inversion stretch, or resisted plantar flexion of the first ray. Active circumduction of the ankle may re-create tendon subluxation. Sobel et al[28] described the peroneal compression test, which is used to assess pain, crepitus, and "popping" at the posterior edge of the distal fibula during forceful ankle eversion and dorsiflexion.

Imaging studies

A weight-bearing anteroposterior and lateral radiograph of the symptomatic ankle and foot are helpful in determining foot morphology such as pes cavus. Radiographs of the contralateral side may be required for comparison. Bone abnormalities such as stress fractures, bone tumours

Fig. 7 Anteroposterior radiograph demonstrating the 'fleck' sign (arrow) of the lateral malleolus due to acute peroneal tendon dislocation. Marked soft-tissue swelling is also seen here.
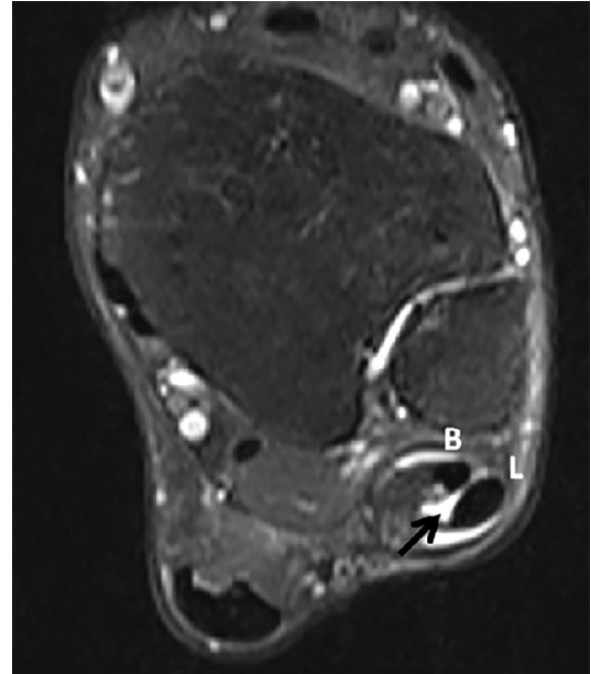
Fig. 8 Axial proton density MR image with fat saturation demonstrating peroneal tenosynovitis. The peroneal brevis (B) and longus (L) appear swollen and there is excessive fluid in the tendon sheath (arrow).

and osteophytes that may contribute to symptoms may also be identified. Oblique views of the foot may demonstrate an enlarged peroneal tubercle as well an os peroneum. The 'fleck' sign on radiographs is pathognomonic of SPR avulsion and may indicate tendon subluxation or dislocation (Fig. 7).

Ultrasound imaging offers the advantage of 'dynamic' real-time imaging of the peronei, and may identify subluxation.[29] Grant et al[30] reported 90% accuracy in diagnosing peroneal tendon tears. Injection of local anaesthetic into the tendon sheath may help localise pain to the peronei; however 15% of cases have communication with the ankle or subtalar joint. We do not advocate the use of steroids which carry a risk of subsequent tendon rupture.

CT scanning is best suited to assess osseous anatomy such as retromalleolar groove morphology, a hypertrophied peroneal tubercle or lateral wall impingement following calcaneal fracture.

MRI may demonstrate concurrent ankle pathology responsible for symptoms such as subtalar arthropathy, talar dome defects, or os peronei. Tendinosis and tenosynovitis are best visualised on T2-weighted or axial proton density weighted images and are characterised by increased signal intensity within the tendon and fluid signal surrounding the tendon. Circumferential fluid within the common peroneal tendon sheath wider than 3 mm is highly specific for peroneal tenosynovitis (Fig. 8).[31] The

'magic' angle effect must be considered before the diagnosis of a peroneal tendon tear is excluded. This occurs as the tendons follow a curved path around the lateral malleolus, rendering tendon fibres 55° to the magnetic axis, resulting in artefactual signal.[32] The effect may mask subtle changes of tendinosis and has been shown to decrease sensitivity and specificity to about 80% and 75% respectively. T2-weighted images (or any sequence with a long echo time) placing the foot in plantar flexion are helpful in reducing this artefact.[16]

Peroneal tendonoscopy

A study by van Dijk and Kort[33] was the first to report tendoscopy of the peronei. The distal portal is first sited 2 cm distal to the fibular tip, in line with the tendon. Using a 2.7 mm portal and saline insufflation of the tendon sheath, the proximal portal is then established 3 cm proximal to the fibular tip. Principally a diagnostic tool, it may be used for simple tenosynovectomy and division of adhesions.

Pathological conditions

Peroneal tendinosis

Patients typically present with posterolateral ankle pain that worsens with activity and improves with rest. There is
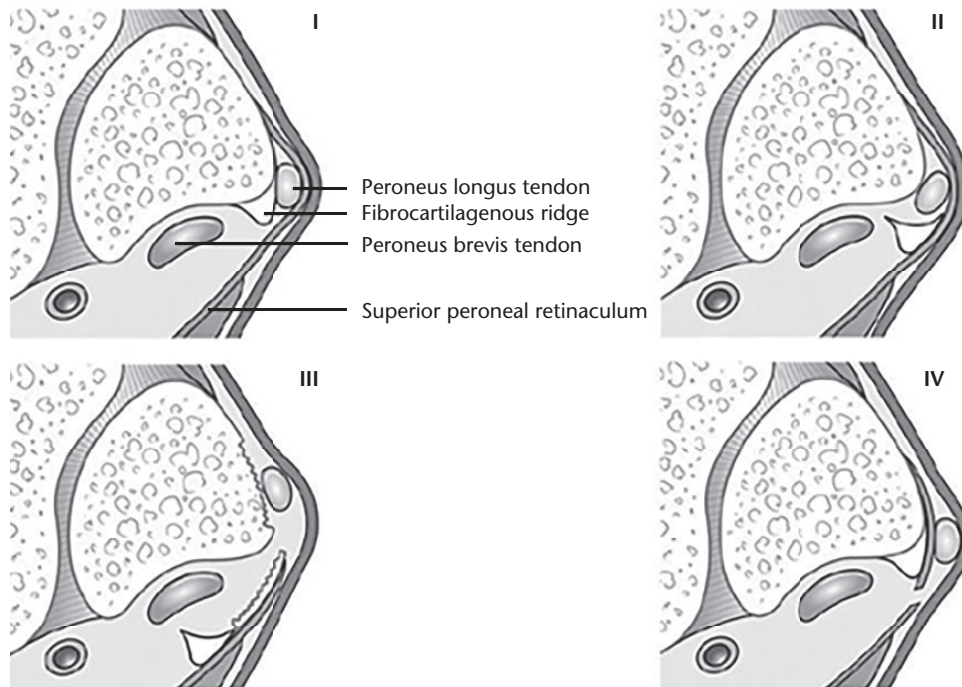
Fig. 9 Classification of peroneal tendon dislocation (reproduced with permission from Bentley G, ed. *European Surgical Orthopaedics and Traumatology The EFORT Textbook.* Berlin: Springer Publications, 2014).[52]

usually tenderness over the peroneal tendons and a palpable mass that moves with the tendon is suggestive of tendinosis. The condition is characterised by thickening, and focal tendon degeneration and swelling, and occurs more commonly in the infra-malleolar portion. There is often associated nodular thickening, splits or tears of the tendon.

Treatment of peroneal tendinosis

Having confirmed the diagnosis with USS or MRI, treatment consists of non-steroidal anti-inflammatory medication, rest, activity modification, and orthoses with lateral forefoot posting in mild cases. In refractory cases, immobilisation in a short-leg cast or controlled ankle movement walker for six weeks may be helpful. The use of corticosteroid injection carries the risk of iatrogenic rupture and is not used within our institution.

If non-operative treatment fails, surgery typically consists of an open synovectomy. The tendon sheath is opened longitudinally and any degenerate area of tendon is debrided. Associated pathology such as a peroneus quartus muscle or hypertrophied peroneal tubercle should be dealt with appropriately. The tendon sheath is left open and unrepaired to prevent post-operative stenosis. Post-operatively, the foot and ankle are placed in a short-leg cast. Weight-bearing in the cast may begin after two weeks. Range of movement and strengthening are started after casting is discontinued at four to six weeks.

Peroneal subluxation and dislocation

The first case of peroneal tendon dislocation was described by Monteggia in 1803.[34] The most common mechanism is forceful dorsiflexion of the ankle, hindfoot inversion with contraction of the peroneals causing disruption of the SPR. A convex retromalleolar groove and a varus heel are risk factors causing instability, and tendon pathology.

In 1976, Eckert and Davis[35] evaluated 73 patients with injury to the SPR and classified three types of injury. Grade I injuries, (51%) were characterised by avulsion of the retinaculum from the lateral malleolus, with the tendons lying between the bone and periosteum. In Grade II injuries (33%), the fibrocartilaginous ridge was avulsed with the retinaculum, the tendons are located between the fibrocartilaginous ridge and the fibula. In Grade III injuries (16%), a thin cortical fragment of bone is avulsed from the fibula. In 1987, Oden[36] added grade IV to this classification in which the SPR is torn from its posterior attachment to the calcaneus and deep investing fascia of the Achilles tendon, the tendon lies superficial to the peroneal retinaculum (Fig. 9).[36]

Treatment of peroneal subluxation and dislocation

Type three acute peroneal dislocation may be treated with a period of below-knee cast immobilisation, however the reported success rate for the other subgroups is very low, between 26% to 57%[37] and surgery is usually required, as described below.
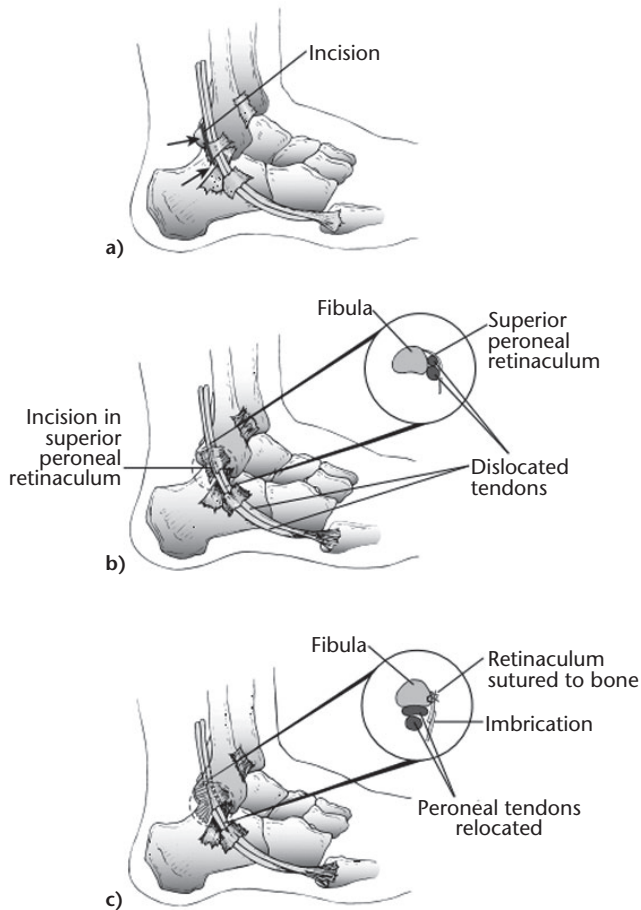
Fig. 10 Surgical repair of acute peroneal tendon dislocation. a) Surgical approach. b) Pathological anatomy demonstrates dislocation of peroneal tendons. c) Repair of superior peroneal retinaculum (SPR) with drill holes through the posterolateral portion of fibula and reefing of SPR (reproduced with permission from Coughlin MJ, Schon LC. Disorders of tendons. In Coughlin MJ, Mann RA, Saltzman CL, eds. *Mann's Surgery of the Foot and Ankle*. Ninth ed. Philadelphia: Mosby Elsevier, 2013:1264).[53]

Direct superior peroneal retinaculum repair: technique

An incision is made in line with the peroneal tendons, starting approximately 1 cm posterior to the fibula, extending 4 cm proximal from its tip to 2 cm distal. The sural nerve is protected and the SPR incised longitudinally. The tendons should be assessed for tears and tenosynovitis and treated accordingly. The fibrocartilaginous ridge is sacrificed, and the SPR re-attached to the retromalleolar groove using transosseous sutures or anchors, with sufficient tensioning to re-locate and allow a smooth excursion of the peronei (Fig. 10). It is then imbricated along the incision line.

Chronic dislocation

Several soft-tissue and bone techniques have been described, with the mainstay of treatment being direct repair of the SPR

Direct repair

The chronically injured SPR is often more redundant than in the acute injury, allowing for a "pants-over-vest" technique. The anterior retinacular flap is double breasted over the posterior flap. High rates of success have been reported,[38] but attention must be given to the shape of the retromalleolar groove and a groove deepening procedure considered.

Retromalleolar groove deepening

Both direct and indirect techniques have been described. The direct method involves elevating the cartilaginous floor of the retromalleolar groove, exposing the cancellous bone beneath. This is then curetted or burred to a point of sufficient concavity to allow tendon excursion. The floor of the groove is then tamped down, the tendons replaced and the SPR repaired as per the technique described above (Fig. 11).[39] The indirect method involves passing a 3.5 mm drill through the fibular tip parallel to the retromalleolar groove, into the subchondral bone. This preserves the floor of the groove, which is tamped down into the drilled tunnel, thus deepening it.[40,41]

Tendon graft reconstruction

The use of the Achilles,[42] peroneus brevis and plantaris tendon[43] have all been described in order to re-inforce the SPR using a transosseous fibular tunnel with varying success.

Bone block procedures

The distal fibula is either rotated or translated posteriorly following a saggital osteotomy, creating a physical barrier to peroneal dislocation. High complication rates including bone displacement, malunion, metal ware irritation, and tendon attrition have been reported.[44]

Tendon re-routing

The peronei can be re-routed under the calcaneofibular ligament, which is translated by either detaching it from the fibular tip or lateral calcaneal wall.[45] This has been associated with high complication rates including sural nerve neuropathy and ankle instability, and has failed to gain popularity.[44]

Intrasheath subluxation

Intrasheath subluxation occurs when the peroneus brevis and longus reverse their anatomical positions within
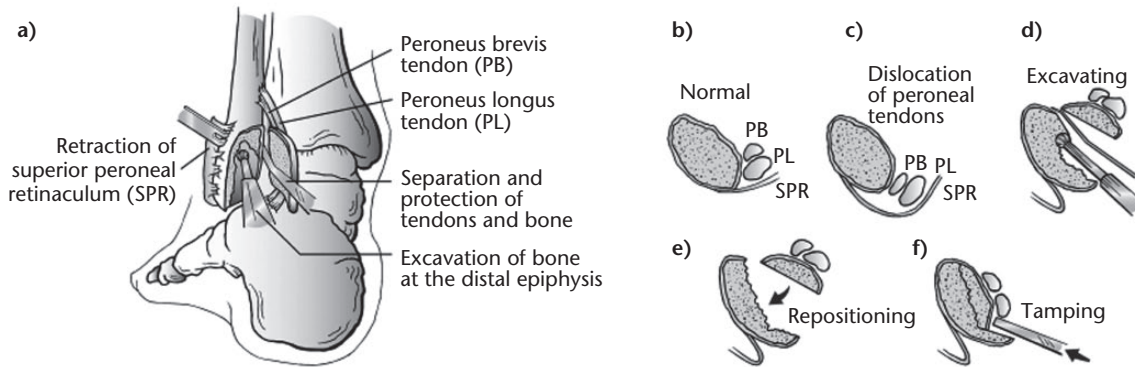
Fig. 11 Operative exposure for groove-deepening procedure. Parallel saw cuts are used to create a trap door (b), which is hinged (c) posteriorly, exposing cancellous bone. d), a curette or burr is used to decompress this area. e) Trap door is impacted into place, creating an offset and deepening the recess posterior to the fibula. f) Peroneal tendons are relocated. g) Drill holes are placed in the fibular lip. h) Sutures are tied securing the superior peroneal retinaculum (reproduced with permission from Coughlin MJ, Schon LC. Disorders of tendons. In Coughlin MJ, Mann RA, Saltzman CL, eds. *Mann's Surgery of the Foot and Ankle*. Ninth ed. Philadelphia: Mosby Elsevier, 2013:1273).[53]
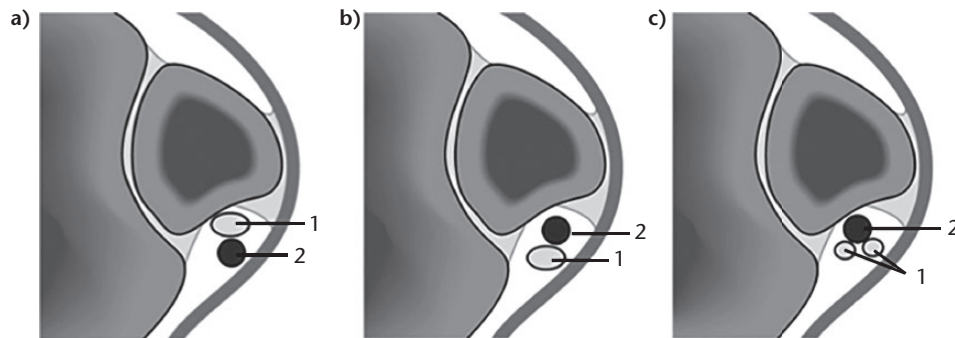
Fig. 12 Intrasheath subluxation of the peroneal tendons. a) Normal position of peroneal brevis (1) and longus (2). b) Subluxation with peroneus longus deep to brevis. c) Peroneus brevis tear with subluxation of longus through the tear (reproduced with permission from Bentley G, ed. *European Surgical Orthopaedics and Traumatology The EFORT Textbook.* Berlin: Springer Publications, 2014).[52]

the peroneal groove, whilst the retinaculum remains intact. Patients present with pain and palpable clicking on ankle circumduction. Raikin et al[46] defines two types: type A involves the peroneus brevis and longus tendon snapping over one another and switching their relative positions (the longus tendon comes to lie deep and medial to the brevis tendon) within the peroneal groove without a tear in the tendons or disruption of the superior peroneal retinaculum. In the other subtype (type B), the peroneus longus tendon subluxates through a longitudinal split tear within the peroneus brevis tendon with a portion of the longus tendon coming to lie deep to the brevis tendon at this level (Fig. 12). The superior peroneal retinaculum is intact. In our experience we have observed type A occurring more commonly than type B.

Dynamic ultrasound with the ankle in dorsiflexion and eversion is best to evaluate this pathology. There is a paucity of literature regarding the long-term results of treatment, however. Groove deepening appears to be an effective means of managing this condition with several small case series reporting a significant improvement in American Orthopaedic Foot and Ankle Society scores in the short term.[46,47]

Peroneal tendon splits and tears

Munk and Davis[48] suggested two possible pathogenic mechanisms for split lesions of the peroneus brevis tendon. The first suggests subluxation of the peroneus brevis tendon occuring as a result of the laxity or tearing of the SPR from chronic ankle instability. In doing so, mechanical attrition occurs over the posterolateral edge of the fibula. In this mechanism, the split lesion follows the subluxation.[28] The second mechanism suggests compression of the peroneus brevis tendon between the posterior fibula and peroneus longus tendon causes a split during an inversion injury.[49] Subluxation of the lateral portion of the peroneus brevis tendon follows the split lesion.

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┌─────────────────────┐   ┌─────────────────────┐   ┌─────────────────────┐
│       Type I        │   │      Type II        │   │      Type III       │
│ Both tendons grossly│   │ One tendon torn,    │   │ Both tendons torn,  │
│       intact        │   │   one usable        │   │     unusable        │
└─────────────────────┘   └─────────────────────┘   └─────────────────────┘
           │                         │                         │
           ▼                         ▼                         │
┌─────────────────────┐   ┌─────────────────────┐             │
│ Repair tendons,     │   │                     │             │
│ excise longitudinal │   │  Perform tenodesis  │             │
│ split, tubularize   │   │                     │             │
│      tendon         │   │                     │             │
└─────────────────────┘   └─────────────────────┘             │
                                                              │
  ┌──────────────────────────┐       ┌────────────────────┐  │
  │ Tendon allograft unlikely│◄──────│     Type IIIa      │◄─┤
  │ to work; perform tendon  │       │ No excursion of    │  │
  │        transfer          │       │   proximal muscle  │  │
  └──────────────────────────┘       └────────────────────┘  │
                                                              │
  ┌──────────────────────────┐       ┌────────────────────┐  │
  │ When the tissue bed is   │◄──────│     Type IIIb      │◄─┘
  │ scarred, consider staged │       │ Excursion of       │
  │ allograft with silicone  │       │  proximal muscle   │
  │          rod             │       └────────────────────┘
  └──────────────────────────┘                │
                                              │
  ┌──────────────────────────┐                │
  │ When there is no tissue  │◄───────────────┘
  │ bed scarring, perform    │
  │ one-stage allograft or   │
  │     tendon transfer      │
  └──────────────────────────┘
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Fig. 13 Algorithm for the intra-operative assessment of peroneal tendon tear (reproduced with permission from Redfern D, Myerson M. The management of concomitant tears of the peroneus longus and brevis tendons. *Foot Ankle Int* 2004;25:695-707).[50]

In patients treated surgically, brevis tendon tears occurred most commonly in 88% of cases, and longus tears more rarely in 13% of cases.[1] Redfern and Myerson[50] suggest tears of both tendons occur in 38% of patients. These are typically associated with cavovarus feet and occur at the level of the cuboid notch. Originally described as an anatomical classification for peroneus longus tears, the Brandes Smith[27] classification is useful for both brevis and longus tears:

- zone A encapsulates tears occurring under the superior retinaculum, typically from subluxation or due to the mass effect of a peroneus quartus or low lying muscle brevis belly;
- zone B is the region of the inferior peroneal retinaculum, where tears maybe associated with peroneal tubercle hypertrophy;
- zone C is at the cuboid notch and is the region where longus pathology occurs most often.

Surgical technique

Using the lateral approach, the retromalleolar groove is entered by incising the SPR leaving a cuff on the fibrocartilage ridge for eventual repair and closure. The surface of each tendon is inspected. Following debridement of the split and excision of the thinner moiety, the tendon is tubularised if over 50% of the brevis remains. This is achieved using a 5-6/0 non-absorbable mono filament suture. If < 50% of the tendon remains following debridement, a tenodesis of the peroneus longus tendon is performed. A side-to-side technique is used for this purpose, tenodesing the proximal tendon end a minimum of 3 cm above the lateral malleolus, and the distal end 5 cm below the fibular tip. This avoids possible stenosis and impingement of the repair in the retromalleolar groove and lateral calcaneal wall.

Redfern and Myerson[50] have outlined a treatment algorithm for the intra-operative assessment of peroneal tendon tears (Fig. 13). Success rates following tenodesis are high at approximately 70% to 80% with return to activity at about 12 weeks.

Peroneal tendon rupture

Where both tendons are degenerate and reconstruction using the above methods not feasible, the options available include tendon transfer, auto or allograft. If there sufficient peroneal muscle belly excursion exists, a hamstring autograft or allograft should be considered. If the muscle belly is scarred and fibrotic, tendon transfer using flexor hallucis longus (FHL) or flexor digitorum longus (FDL) is preferable. If the tendon sheath is fibrotic, a staged approach can be used: the first stage involves excising the scarred tissue and implanting a 6 mm silastic rod in the peroneal muscle bed, suturing it to the distal tendon. The second stage is performed six to 12 weeks later when a pseudosynovial sheath has formed.[51]

FDL or FHL transfer

The patient is placed supine with a sandbag under the ipsilateral hip and a thigh tourniquet used. The flexor tendon is approached medially along the midfoot, inferior and distal to the navicular. This is harvested at the knot of Henry. A proximal incision 7 cm above the medial malleolus is made and the tendon pulled proximally. Corresponding incisions are made laterally and the tendon end passed into posterior to the tibia into the peronei sheath. It is pulled in to the lateral midfoot where it is repaired directly to the peroneus brevis tendon stump or through a drill hole in the fifth metatarsal base.

Autograft or allograft

Where the tendons are damaged but proximal muscle excursion remains, a hamstring or extensor tendon graft can be used. The extensor tendon can be harvested distally at the level of the metatarsophalangeal joints through a small incision. It is then passed through a small proximal incision at the ankle joint. The tendon size is assessed and can either be doubled up or additional tendons harvested to provide a graft of adequate size. The graft is attached to the proximal peroneus brevis and routed behind the lateral malleolus. The distal end is secured either to peroneus brevis tendon stump or through a drill hole in the fifth metatarsal base.

Painful os peroneum syndrome

The peroneus longus tendon is exposed at the cuboid tunnel and a tagging suture placed in the distal portion. The os peroneum is shelled out from the tendon and if a defect remains, a direct repair performed. If the repair is not achievable, a tenodesis of the longus to brevis should be performed proximally, excising the degenerate section of longus.

Treatment of associated pathology: varus hindfoot deformity

The majority of patients with atraumatic peroneal tendon symptoms have a varus heel. This should be assessed during initial clinical examination and correction of hindfoot alignment considered in surgery. This can be addressed using a lateralising calcaneal osteotomy, and a dorsiflexion osteotomy of the first ray. In our institution, the calcaneal osteotomy is performed through a 'L' shaped lateral hindfoot incision, although an oblique direct incision or minimally-invasive technique have also been described. Full thickness flaps should be elevated to minimise the risk of iatrogenic injury to the sural nerve and to preserve the vascularity of the flap.

Treatment of associated pathology: valgus hindfoot deformity

The peronei can become entrapped between the fibular tip and lateral calcaneal wall. The foot should be assessed for a planovalgus deformity and correction considered in the form of a medialising calcaneal osteotomy and tibialis posterior tendon reconstruction.

Treatment of associated pathology: post-calcaneal fracture deformity

A widened heel with a varus or valgus deformity following calcaneal fracture, may leave the patient prone to tendon impingement. Exostectomy of the lateral calcaneal wall through a lateral approach, as described above, may be carried out and the tendons explored accordingly.

Post-operative care and rehabilitation

We generally advise a non-weight-bearing back slab until a two-week wound check. A cast, walking boot or brace will then be used depending on the procedure performed and physiotherapy will be commenced accordingly.

The diagnosis of peroneal tendon disorders is often missed in the evaluation of the patient with lateral ankle pain. Understanding the functional expectations of the patient is useful in selecting the best course of treatment. Patients with minimal symptoms and loss of function often do well with a non-surgical approach. In contrast, higher-demand patients with more loss of function, especially those involved in athletic activities, may benefit from surgical treatment. A thorough history and physical examination, combined with judicious use of imaging techniques, should aid in making the correct diagnosis. The peroneal tendon pathology, the associated ankle pathology and the correction of underlying foot morphology must all be considered when planning surgery. Awareness of these disorders, their characteristics, and treatment options provides a more rapid diagnosis for the patient and a more effective management algorithm.

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