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Case Reports and Series

Inferior peroneal retinaculum tear with isolated peroneus longus tendon dislocation: A case report of an extremely rare Injury, with the proposal of an innovative repair technique

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Peroneus longus tendon (PLT) dislocation associated with inferior peroneal retinaculum (IPR) tear is an extremely rare injury. Only 6 cases are described in English literature to date, and its diagnosis is always delayed from the initial trauma. Swelling at the lateral face of the heel and a snapping during the movement of the foot and ankle are typical signs that can induce the suspect of this injury. Operative treatment is required as it typically affects young adults with high functional demands and tendon instability causes pain and functional limitation; also, a neglected dislocated or instable PTL may eventually end up with a rupture. In the few cases reported in literature, different operative techniques have been described, all with excellent results. A case of an initially overlooked dynamic dislocation of the PLT due to IPR tear in a young professional soccer player is described. The lesion was treated with a not yet described operative technique that consists in groove deepening and subsequent IPR repair through transosseous sutures, instead of peroneal tubercle resection as mostly advocated. Final follow up at 15 months showed complete recovery, with a Foot and Ankle Outcome Score of 100%.

Subluxation or dislocation of peroneal tendons is a relatively rare injury generally resulting from acute ankle sprain, particularly when violent dorsiflexion combines with eversion and a reactive contraction of the peroneal muscles. Young athletes are most frequently affected.[1] Dislocation of peroneus longus tendon (PLT) and the peroneus brevis tendon (PBT) typically occurs at the level of the retro-malleolar groove, a fibro-osseous tunnel bounded by the superior peroneal retinaculum (SPR),[2] at the ankle (Brandes and Smith's zone A).[3] Four types of dislocation have been described, according to the classification of Eckert and Davis[4] proposed in 1976, lately revised by Oden[5] in 1987. Acute peroneal dislocations are misdiagnosed in up to 40% of cases, often mistaken for lateral ankle ligament sprains.[6]

While dislocations at the level of the SPR are well known and classified, tears of the inferior peroneal retinaculum (IPR) are extremely rare and still frequently overlooked. Anatomically, below the retro-malleolar groove (Brandes and Smith's zone B), the two tendons separate and are enclosed in two distinct synovial sheaths. They both cross the lateral calcaneal wall, separated by the peroneal tubercle and a septum, where the sheaths thicken and form the IPR. The PBT passes above the tubercle while the PLT passes below it to continue into the cuboid tunnel (Brandes and Smith's zone C)[3,7] to insert more frequently onto the first metatarsal bone.[8] The peroneal tubercle can present different anatomical shapes (it can be flat, prominent, concave or presenting as a tunnel) that may correlates with different peroneal tendon pathologies.[9] Also, magnetic resonance imaging (MRI) -based[10] and computed tomography (CT) scan -based[11] descriptions have been proposed (Table 1). The traumatic mechanism that leads to IPR rupture and PLT dislocation seems to be the same as the one that leads to SPR rupture. Only sporadic cases of IPR rupture are described in literature and there are no standardized procedures for treatment.[12] The PLT dislocates from below to over the peroneal tubercle on the lateral face of the heel. The dislocation can be fixed or "dynamic", with the PLT that dislocates with eversion and then it can re-locate spontaneously, or the patient can re-locate it by hand. Pain and swelling at the lateral face of the heel combined with a "popping" or "snapping" sensation are typical signs of this injury. The diagnosis is frequently (if not always) delayed and all the cases described in the literature have been treated with an operative procedure. To our knowledge, only 6 cases of PLT dislocation for IPR lesion have been reported in the English Literature to date.[13–16]

A case of IPR injury associated with isolated PLT dynamic dislocation is presented, and an operative technique is described that allows for anatomic

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Table 1
Classifications available for defining the shape of the peroneal tubercle.

Anatomical classification by Hyer et al. (2005)		MRI-based classification by Taneja et al. (2013)		CT scan-based classification by Vosoughi and Tabatabaei (2021)	
114 cases	% (n)	121 cases	% (n)	100 cases	% (n)
absent	9.6%[11]	absent	55.4% (67)	absent	0% (0)
flat	38.6% (44)	triangular	37.2% (45)	single-convex	59% (59)
prominent	26.3% (30)	plateau	7.4%[9]	double-convex	24% (24)
concave	24.6% (28)	tunnel	0% (0)	plateau	9%[9]
tunnel	0.9%[1]			convex-concave	8%[8]

Abbreviation not used in text: n = number of cases.

reduction of the PLT and anatomic repair of the IPR without resecting the peroneal tubercle,[15] nor weakening the superior portion of the IPR,[14] nor using hardware.[13] A very similar operative technique has been recently published by Lohrer,[16] of which the Authors were not aware at the time of surgery nor when this paper was initially submitted for publication.

At our centre, no Institutional Review Board nor Ethical Committee Approval is necessary for case report studies, and Patient gave his consent to data collection and anonymous use of them for scientific and teaching purposes.

Case Report

In October 2019, an 18-year-old boy came to the Emergency Department (ED) after a left (dominant) ankle sprain during soccer training. At physical examination there was swelling at the lateral malleolus and at the lateral face of the heel. Radiographs were negative for fractures. RICE (Rest, Ice, Compression, Elevation) protocol and subsequent progressive functional recovery based on symptoms were recommended. Patient went back to the ED the day after, still complaining of pain and local swelling. New radiographs were taken, a suspicion of osteochondral lesion was proposed and MRI was scheduled for the next day. MRI was reported to be negative and patient discharged with previous RICE recommendations. At 3 weeks from trauma, patient came to our attention for a second opinion. He reported the persistence of pain and swelling associated with an annoying sensation described as a "pop" at the lateral face of the heel during walking. A tender and mobile lump was very well localized distal and anterior to the apex of lateral malleolus, and it was reducible by the examiner with a simple maneuver but also it reappeared with active eversion/dorsiflexion. The diagnosis of IPR tear with PLT dislocation was proposed, as MRI actually showed (Fig. 1), and a dynamic ultrasound (US) evaluation was prescribed. Unfortunately, US examination was performed by a Radiologist who misdiagnosed the lesion as just a PBT thickening (Fig. 2). Patient was informed that such IPR tear with dynamic PLT dislocation could be frequently overlooked and/or misdiagnosed, that to our opinion the diagnosis appeared clinically evident, and that operative intervention was recommended.

Operative technique. Patient was positioned in the contralateral decubitus position, under spinal anesthesia, and a pneumatical tourniquet (pressure 250 mmHg for 30 min) was inflated at the thigh. The lump was evident distal and anterior to the lateral malleolus, and anatomical sketch was drawn on the skin of Patient (Fig. 3). A 4-cm oblique incision centered on the swelling, midway from the apex of the lateral malleolus to the base of the fifth metatarsal bone, was made. After blunt dissection of superficial tissues and mobilization of the skin, scar tissue over a lump that was mobile was found (Fig. 4). Sharp section of this tissue revealed that it included the torn inferior portion of the IPR, and the lump to be the PLT dislocated superiorly on the top of the peroneal tubercle (Fig. 5). After reduction of the PLT under the peroneal tubercle, the PBT was observed to be intact in its anatomical seat under the superior portion of the IPR (Fig. 6). The flaps of the IPR were prepared for subsequent reinsertion. Groove deepening was performed inferiorly to the peroneal tubercle with a rongeur and curettes (Fig. 7A), and the PLT was replaced in its anatomical site (Fig. 7B). Then, reconstruction of the IPR was performed. First, a trans-osseous suture of the posterior flap of the IPR was performed with 3 absorbable braided No. 0 sutures passed from the apex the peroneal tubercle to mid-distance of the flap (Fig. 8A). Care was taken to have the entry point of the transosseus sutures slightly inferior to the edge the peroneal tubercle (where the inferior portion of the IPR inserts) and the exit point over the superior surface of it, to reduce the risk of iatrogenic fracture. Also, care was taken to have correct tension of the posterior flap of the IPR, so to hold back the PLT into the groove. Sutures were tightened with knots on the superior surface of the peroneal tubercle (Fig. 8B). Afterwards, an overcoat suture (with absorbable braided No. 0 sutures) of the superior flap over the inferior flap of the IPR was performed (Fig. 9). Skin closure was obtained with running intradermal suture using an absorbable monofilament No. 4–0 suture (Fig. 10), and the leg put into a fixed walker boot.

Postoperative care. The fixed walker boot was worn permanently, and weightbearing as tolerated was allowed immediately after surgery. At 4 weeks from surgery, the walker was used only to ambulate and at night, active range-of-motion (ROM) exercises in flexion-extension of the tibiotalar joint and passive ROM exercises in prono-supination of the subtalar

Fig. 1. Coronal (**A**), axial (B) and sagittal (**C**) T2-weighted magnetic resonance images: the peroneus brevis tendon (arrow) is in its anatomical place over the peroneal tubercle (§), while the peroneus longus tendon (PLT, arrowhead) is dislocated superiorly and anteriorly; concomitant tenosynovitis of the PLT is present.

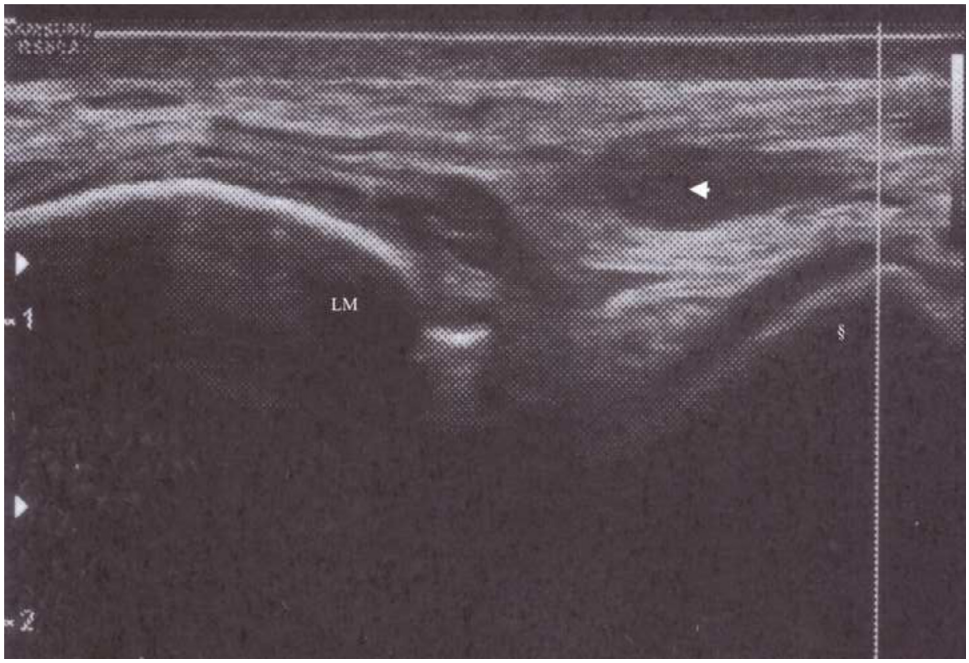

Fig. 2. Ultrasound imaging: the peroneus longus tendon (arrowhead) is dislocated proximal to the peroneal tubercle (§); the peroneus brevis tendon is not discernable from the bone surface of the calcaneus where it lays, between the lateral malleolus (LM) and the peroneal tubercle.

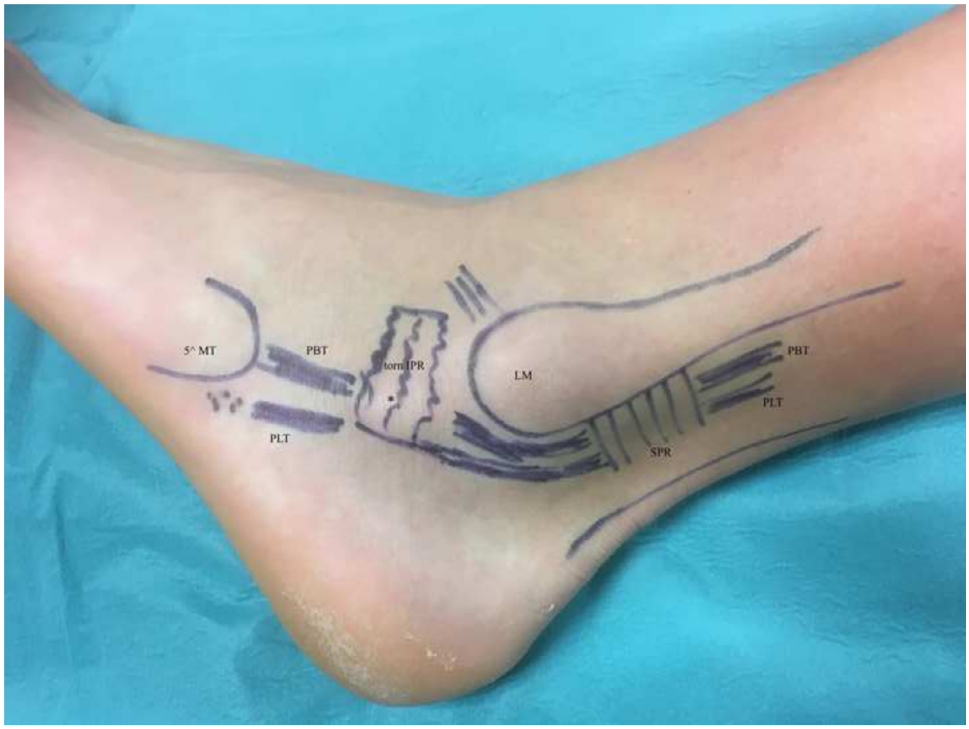

Fig. 3. Anatomical sketch before operative prepping. A lump (*) is visible distal and anterior to the lateral malleolus (LM), midway to the base of the fifth metatarsal bone (5^ MT), at the level of the torn inferior peroneal retinaculum (IPR). The routes of the peroneus brevis tendon (PBT) and peroneus longus tendon (PLT) from the superior peroneal retinaculum (SPR) towards their insertions are also drawn.

joint were begun; also, partial weightbearing proprioceptive exercises were introduced. At 6 weeks from surgery, active ROM exercises in subtalar prono-supination and weightbearing proprioception were allowed. At 8 weeks from surgery, the walker was discontinued. Running and simple sport-specific activities were allowed at 3 months from surgery, and agonistic activities at 4 months.

Follow up (FU) evaluation. At 4 months from surgery, MRI evaluation showed the PLT in place under the peroneal tubercle, and continuity of the reconstructed IPR (Fig. 11). Patient was back to his agonistic activities at 5 months from surgery, playing without any complaint. Last FU was at 15 months from surgery, the patient has complete foot and ankle ROM, no pain nor tenderness were reported. Clinically, there were no signs of PLT dislocation or instability, neither under contraction against resistance. No strength deficits were clinically recorded, as well (Fig. 12). Patient reached a FAOS (Foot and Ankle Outcome Score) of 100% (Symptoms + Stiffness subtotal: 100%, Pain subtotal: 100%,

Fig. 4. The mobile lump is the dislocated peroneus longus tendon that can be reduced, covered by torn inferior peroneal retinaculum and scar tissue.

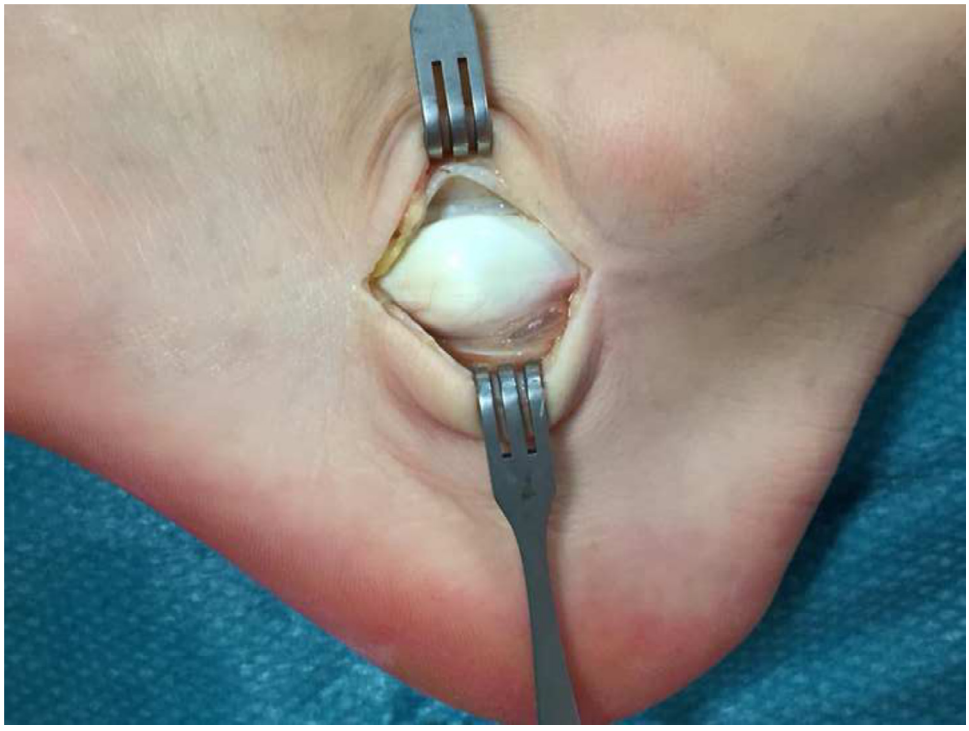

Fig. 5. Sharp dissection of scar tissue revealed the dislocated peroneus longus tendon.

Function, daily living subtotal: 100%, Function, sports and recreational activities subtotal: 100%, Quality of life subtotal: 100%).

Discussion

Isolated PLT dislocations associated with IPR tears is an extremely rare pathology. To our knowledge, there are only 6 previous cases described in 4 articles (Table 2)[13–16] in the English literature. On the other hand, PLT tendinopathy and/or rupture is more frequent and described as possibly associated with peroneal tubercle pseudohypertrophy.[12] As the peroneal tubercle presents with different shapes,[9] we can speculate that a flat or a concave peroneal tubercle can predispose to PLT dislocation, while a prominent or presenting like a tunnel tubercle can predispose to PLT tendinopathy / tenosynovitis and subsequent rupture. MRI-based[10] and CT scan-based[11] clinical studies found a correlation between larger dimensions of the peroneal tubercle and peroneal

Fig. 6. Peroneus longus tendon relocated under the peroneal tubercle (§) of the calcaneus. The superior portion of the inferior peroneal retinaculum (#) is intact.

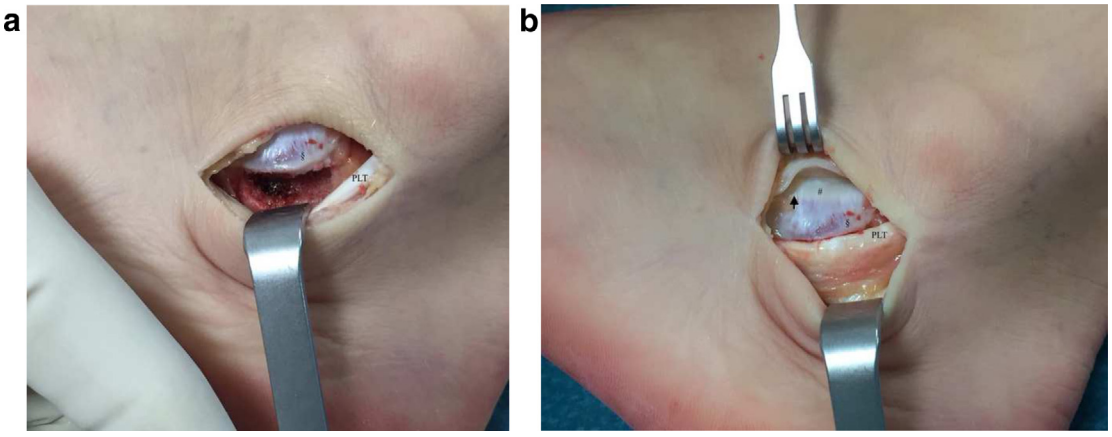

Fig. 7. (**A**) Groove deepening has been performed under the peroneal tubercle (§). (**B**) The peroneus longus tendon (PLT) has been relocated in its anatomical site; again, the peroneus brevis tendon (arrow) is well visible under the intact superior portion of the inferior peroneal retinaculum (#).

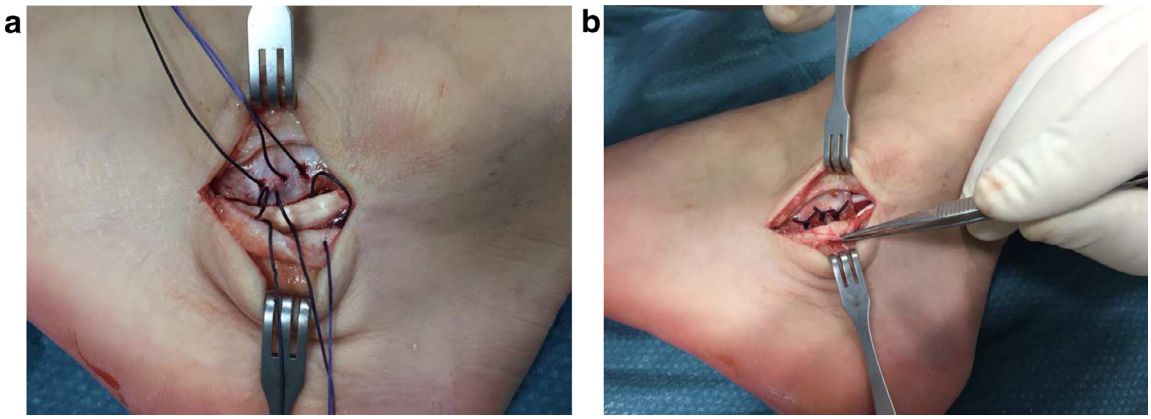

Fig. 8. (**A**) Transosseous suture of the posterior flap of the inferior peroneal retinaculum (IPR) was performed with 3 absorbable braided No. 0 sutures passed from the apex the peroneal tubercle to mid-distance of the flap. (**B**) Suture are tied on the superior aspect of the peroneal tubercle; again, the peroneus brevis tendon is very well visible proximally before passing under the superior portion of the IPR.

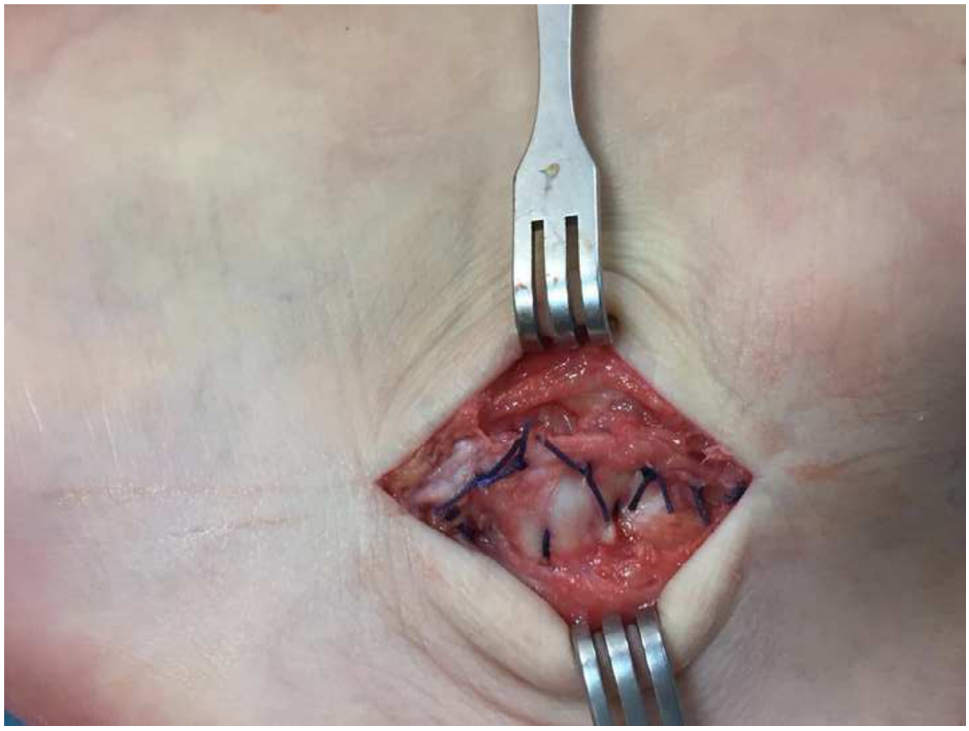

Fig. 9. An overcoat suture of the superior flap over the inferior flap of the inferior peroneal retinaculum is completed.

Fig. 10. The 4-cm skin incision is closed with running absorbable suture.

partial tears, tenosynovitis, or any tendon abnormality, but no correlation between shape and pathology; no subluxation/dislocation of the peroneal tendons were reported as included pathology. Unfortunately, these Authors took into account different parameters and used a different terminology than previously reported. So, the three classifications (anatomical, MRI-based, and CT scan-based) seem difficult to be compared and/or integrated to each other. Of the 7 cases of PLT dislocation described in Literature, in 3 cases the peroneal tubercle was concave (Klos et al., 2011, presented case) or "not prominent",[14] in 3 cases Authors did not described the shape of it,[15] and in one case "single-convex" with normal size.[16]

Traumatic IPR rupture and PLT dislocation seem to be typical of the young adult following an ankle sprain during sports activity without pre-existing deformities of the foot or ankle. Five out 7 cases presented a clear initial trauma, while in 2 cases[14,16] All cases described showed the presence of swelling and/or a lump at the lateral side of the hindfoot

Fig. 11. Coronal (**A**) and sagittal (**B**) T1-weighted and axial T2-weighted (**C**) magnetic resonance images: the peroneus brevis tendon (arrow) and the peroneus longus tendon (arrowhead) are running over and below the peroneal tubercle (§), the repaired inferior peroneal retinaculum (<) is visible.

Fig. 12. Clinical result at 8-months follow-up. Operative scar is slightly hyperchromic. No lump was evident at contraction against resistance, nor strength deficit was appreciable.

associated with local tenderness. A visible or palpable "snapping" or "popping" is a typical sign that demonstrates the presence of instability of the PLT. A diagnostic delay is common because the symptomatology is easily mistaken for a normal ankle sprain with ligamentous involvement of the lateral side. Instead, this injury has to be suspected in case of persistent swelling / lump on the lateral face of the heel and when the patient reports a snapping sensation during walking or during ankle inversion movements.[12]

The clinical suspect resulting from a careful physical examination can be subsequently confirmed by instrumental examinations. US examination offers the advantage of "dynamic" real-time imaging of the peroneal tendons and may identify subluxation / dislocation with accuracy of 94%.[17] MRI may provide crucial information about the condition of the peroneal retinaculum, the tendon sheath, tenosynovitis or tendon tears[1,18]; static images can also be acquired with the PLT dislocated and reduced to better documented the instability. Conventional radiology and computed tomography can be useful to rule out associated fractures or pre-existing anatomical anomalies. However, Radiologists should be dedicated to musculoskeletal imaging and should be aware of the pathology. Also, she/he should be available to perform a dynamic US evaluation or a double MRI acquisition. US evaluation seems to be more sensitive and accurate than MRI in the detection of foot and ankle tendon pathology,[17] and imaging acquisition with the PLT in the reduced position may lead to overlooking the lesion and misdiagnosed the IPR rupture with PLT instability. The presented case had epidemiological and clinical features similar to the other cases described in literature: young adult, agonistic sportswoman/man, ankle sprain trauma, swelling at the lateral side of the hindfoot, palpable painful snapping, diagnostic delay of about 30 days.

This is a very rare pathology, and limitations of case reports are well known. Nonetheless, agreement between Authors about the need for surgery is present, as it leads to predictable and excellent results while

Table 2
All cases of peroneus longus tendon dislocation associated with inferior peroneal retinaculum tear described in English literature.

Authors	n	Gender	Age	Sport	Trauma	Initially overlooked	Peroneal tubercle shape (anatomical classification by Hyer et al.)	Surgery
Klos et al., 2011	1	M	23	Soccer	Y	Y, 4 weeks	concave	Groove deepening + IPR reconstruction (periosteal flap fixed with anchor)
El Rassi et al., 2012	1	F	23	Ice skating	N	Y, 18 months	not prominent	IPR reconstruction (proximal part of the superior portion of IPR used as a rotational flap)
Staresinic et al., 2013	3	M	23	Soccer	Y	Y, 10 weeks	n.r.	Peroneal tubercle excision + groove deepening + IPR plasty
		M	20	Soccer	Y	Y, < 4 weeks	n.r.	
		M	28	Soccer	Y	Y, < 4 weeks	n.r.	
Loher, 2020	1	M	25	Speed skating	N	Y, 10 months	single-convex*	PLT partial resection + groove deepening + IPR reconstruction
This paper	1	M	18	Soccer	Yes	Y, 4 weeks	concave	Groove deepening + IPR reconstruction

* based on CT scan -based classification by Vosoughi and TabatabaeiAbbreviation not used in text: n = number of cases, M = male, F = female, Y = yes, N = no, n.r. = not reported.

conservative treatment does not.[12] Anyway, there is no standardization regarding the operative technique. In the presented case, the excision of the peroneal tubercle was not performed, the PLT was stably relocated in its anatomical seat thanks to the groove deepening, the inferior portion of the IPR was reinserted through transosseous sutures and reinforced with an overcoat suture. A very similar technique was recently published,[16] in which bone removal was performed with a drill and curettes to spare the chondral bottom of the groove that was afterwards impacted. Also, IPR plasty was performed with transosseos sutures.

It is our opinion that this operative technique guarantees an anatomical reconstruction, without altering the PLT route and ensuring adequate strength of the IPR without the use of any hardware. On the other hand, transosseous sutures at the tip of a small apophysis can fracture it. In particular, the differences in the various techniques described concern the modality of reconstruction of the IPR, the usefulness of excision of the peroneal tubercle and the need to perform a groove deepening. In our opinion, previously proposed techniques present potential weakness, even if they were successful in treating the PLT dislocation / IPR rupture. Klos et al[13] treated their case with groove deepening and reconstruction of IPR with suture anchor, using a dorsolaterally-based periosteal flap. Periosteum of the calcaneus is not so thick to be adequately lift and to guarantee sufficient strength of the reconstruction in all patients. Also, the use of hardware is more expensive and can lead to future complications such as mobilizations and infections. El Rassi et al[14] described a case treated exclusively with IPR reconstruction with part of its superior portion. They did not create a groove, not addressing the shape of the tubercle that eventually predisposed or contributed to the dislocation. Moreover, using a part of the superior portion of the IPR, their reconstruction may not be enough strong and eventually also the PBT can dislocate if the remaining part of the superior portion of the IPR tears. Staresinic et al[15] described 3 cases of professional soccer players successfully treated with peroneal tubercle excision, lateral calcanear groove creation for both PLT and PBT, and IPR plasty. They resected the peroneal tubercle, but it can have a role as a pivot for PLT function: it shifts posteriorly and inferiorly the PLT route, and therefore the PLT has a more everting and plantarflexing vector than without the tubercle. Peroneal tubercle resection has been described as successful in patients with PLT tendinopathy associated with peroneal tubercle enlargement,[12] and therefore our concerns about rerouting should be minimized.

In conclusions, PLT dislocation and/or instability associated with IPR tear is a very rare pathology that must be known and recognized as it requires operative treatment. A visible and/or palpable snapping at ankle dorsiflexion/eversion on the lateral aspect of the hindfoot with the appearing of a lump that disappears by a simple manual maneuver is pathognomonic of the lesion. Imaging (US, MRI) should be dynamic to better highlight such a rare entity. In our opinion the reconstruction of the IPR with transosseous sutures associated with groove deepening is an optimal treatment method that guarantees excellent functional results and an early recovery with low risk of complications, respecting the anatomy and function of the peroneal tubercle. Greater number of cases described in the literature is deemed to guarantee a standardization of the operative technique. Also, consensus should be found in describing the shape of the peroneal tubercle, with regards to terminology and methods of measurements.

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Patient Informed Consent Statement

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Declaration of competing interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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