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Distal Peroneus Longus Dislocation and Pseudohypertrophy of the Peroneal Tubercle: A Systematic Review

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ABSTRACT

Peroneal tendon injuries at the peroneal tubercle are rare. No systematic research regarding this pathology is currently available. In this systematic literature review, the author evaluated the present knowledge about peroneal tendon lesions at the lateral calcaneal wall. These lesions are predominantly associated with peroneal tubercle enlargement. Information on 25 respective patients (26 cases) has been published in 14 articles. Until now, only 3 reports presented 5 patients with dislocation of the peroneus longus tendon combined with inferior peroneal retinaculum lesions. In these cases, the peroneal tubercle was not enlarged. All reviewed patients were treated surgically. Enlarged peroneal tubercles were resected. Groove deepening and inferior peroneal retinaculum reconstruction addressed distal peroneus longus tendon dislocations. The reported results were either excellent or good. Recurrent dislocations can cause lesions of the peroneus longus tendon at the peroneal tubercle. This pathology is rare and can be addressed surgically. In cases without tendon dislocation, the enlarged peroneal tubercles are removed or shaped, whereas dislocations in normal shaped peroneal tubercles require groove deepening and inferior peroneal retinaculum reconstruction.

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Injuries of the peroneal tendons are rare and are described to be one of the causes of lateral ankle and rearfoot pain (1,2). In principle, dislocations, tenosynovitis, and tears have to be differentiated. Tears can be longitudinal or transversal and have been described in up to 37% of cadaver dissections and ankle instability operations (3). The peroneus brevis tendon is more prone to injury in the fibular groove, whereas the peroneus longus tendon is most frequently injured around the peroneal tubercle (anatomically correct called “trochlea”) and more distally at the cuboid tunnel (4,5). Peroneal tendon dislocations at the tip of the lateral malleolus are thought to result from an injury of the superior peroneal retinaculum and occur most frequently in conjunction with ankle sprains (5,6). Conservative treatment of peroneal tendon dislocations is thought to fail frequently or lead to unpredictable results; therefore, surgical therapy is generally recommended (5,7). Several surgical methods have been described in the literature (6,8). The principle is either to deepen the fibular groove or to reconstruct the superior peroneal retinaculum with soft tissue procedures (5,8).

Anatomically, a peroneal trochlea is found in up to 90% in the middle third of the lateral calcaneus (9). The peroneus brevis tendon runs anterior-superior, and the peroneus longus tendon runs posterior-inferior (4,9). A “prominent and enlarged peroneal tubercle” (>5-mm height) is prevalent in about 20% and is thought to be able to cause stenosing peroneal tenosynovitis (4). A 2011 literature review stated that “a tear of the peroneus longus as a consequence of chronic friction of the tendon over the enlarged peroneal tubercle is reasonable, but has not been described” (4). Three years later, the same authors presented 2 cases with that lesion (10).

The aim of this study is to present a systematic literature review to update the knowledge about peroneal tendon lesions at the lateral calcaneal wall.

Materials and Methods

Search Strategy

To find an overview of available literature for peroneal tendon lesions at the peroneal tubercle, we systematically searched the PubMed/MEDLINE database via Reference Manager and the Cochrane Library Database electronically from the earliest dates up to November 4, 2017. We searched titles and abstracts for the terms (peroneal) OR (peroneus) OR (peroneus) AND (rupture) OR (tear) OR (dislocation) OR (sprain) OR (subluxation) OR (tenosynovitis) AND (tubercle) OR (trochlea). Inclusion criteria for this review were descriptions of patients who had and were treated for peroneal tendon lesions at

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the lateral calcaneal wall and interference with the peroneal trochlea. Titles, abstracts, and, where questionable, full-text articles were screened for inclusion. Articles dealing with peroneal tendon lesions below or above the peroneal trochlea area, cadaveric studies, incomplete case reporting, isolated anatomic and magnetic resonance imaging (MRI) investigations, and different pathologies (eg, tumors) were excluded (Fig. 1). No institutional review board approval was sought for this investigation because only previously published material without personal identifying information was collected, and the trial registration number is DRKS00013255. (The data sets used and analyzed during the current study are available from the author on reasonable request.)

Statistical Analyses

When pooling of the data was reasonable, statistical analyses were carried out by using Microsoft Excel 2013. Statistical analyses were performed with descriptive data analyses as median and range values. Comparisons were performed by using the Mann-Whitney *U* test. The level of significance was set at $p < .05$.

Results

The electronic literature search identified 40 articles (Fig.). Citation tracking and reference checking revealed 2 additional articles that were possibly relevant. Seventeen articles were included in the final analyses. Overall, 14 articles described 25 patients (26 cases) with peroneal tendon lesions associated with peroneal tubercle hypertrophy (Table 1).

Three articles described peroneus longus dislocations over a normal-sized peroneal trochlea in 5 patients (11–13). With the addition of the case report of 1 patient from our center, a total of 6 patients with peroneus longus tendon dislocation over the peroneal trochlea have been described (Table 2). All patients with dislocation of the distal peroneus longus tendon had a normal-sized peroneal tubercle. All of the patients played different sports competitively. In the enlarged peroneal tubercle group, 9 cases were associated with sports (4 of them with soccer) and 13 cases were not. The median age for patients was 23 (range 20 to 28) years in the dislocation group and 38 (range 11 to 60) years in the group without dislocations ($p = .02$). There were 5 males and 1 female in the dislocation group. In the enlarged peroneal tubercle group, there were 14 males and 11 females. One patient in the enlarged peroneal tubercle group had a bilateral occurrence. Only 1 of 6 patients with distal peroneus longus dislocations had an additional peroneus longus tendon split tear. In the enlarged peroneal tubercle group, 9 of 25 cases were associated with partial split lesions of the peroneus longus tendon (4 cases) and peroneus brevis (5 cases) tendon (Table 1). In the enlarged peroneal tubercle group, an inducing injury (ankle sprain) was reported in 6 of 20 cases, respectively. Three of the 6 cases with peroneal tendon dislocation at the peroneal trochlea were associated with an ankle sprain. Two patients with preexisting complex foot deformities (heel varus,

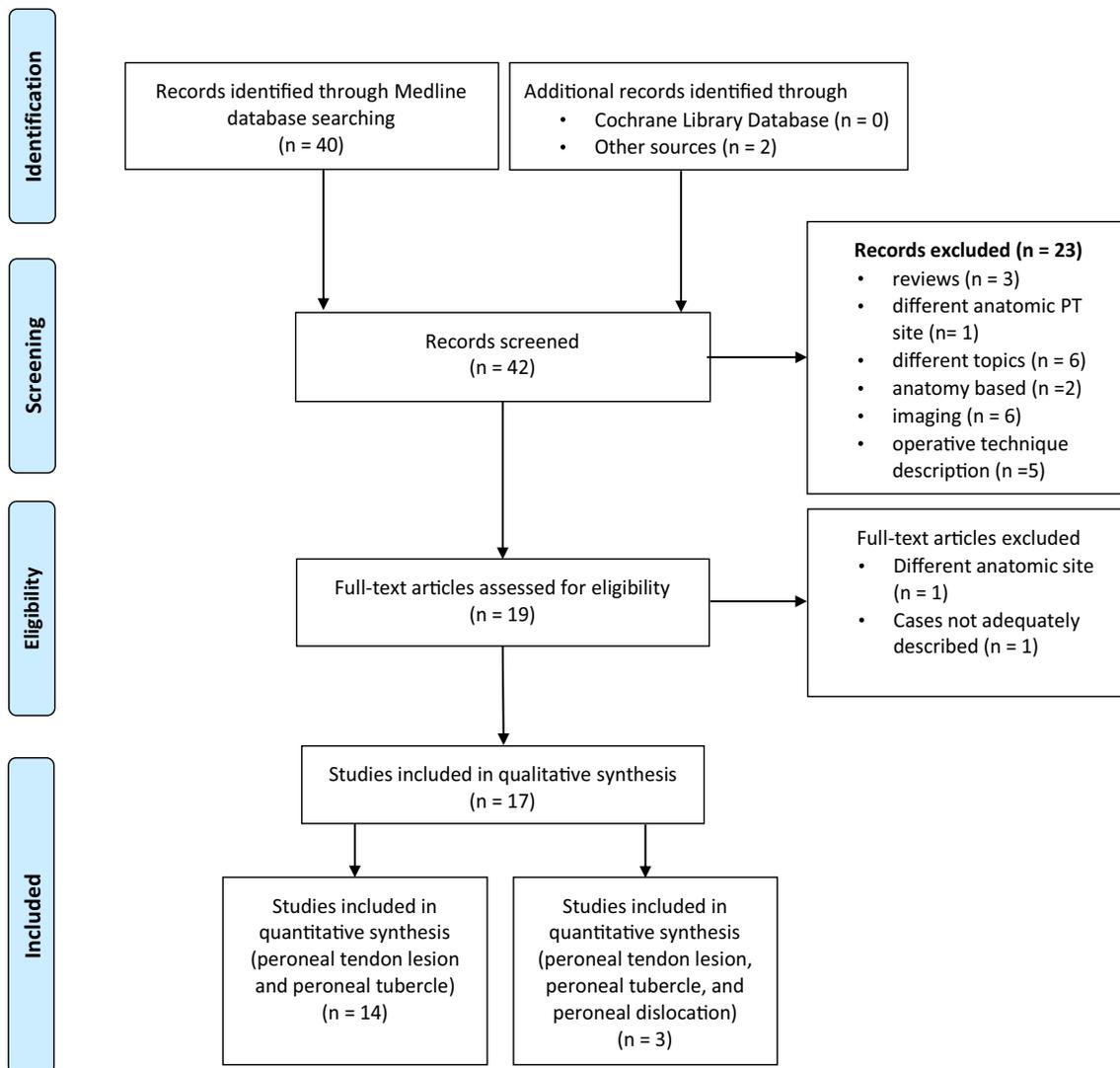


Fig. 1. PRISMA flow diagram illustrating the search strategy and use of the reviewed literature for this systematic review. From Moher et al (32).

Table 1
Results of literature analysis for peroneal tendon lesions associated with enlarged peroneal tubercles

Author(s)	N	Sex male/ female)	Age (y)	Sport	Involved Tendon	Injury	Additional Injuries/ Anomalies	Peroneal Trochlea Enlarged	Preoperative History (mo)	Symptoms	Snapping	MRI	Conservative Treatment	Operative Technique	Latest Fu (mo)	Result at Latest Follow-Up
Restuccia et al, 2016 (22)	1	1/0	26	N/A	PBT, PLT	Ankle sprain 10 years ago	No	Yes	N/A	Posterolateral foot pain, difficulty wearing shoes	No	PLT tenosynovitis	Elastic tape, NSAID	PT resection	N/A	Completely healed
Tiwari et al, 2015 (26)	1	0/1	40	N/A	PBT	Ankle sprain	N/A	Yes	2	Swelling, pain, difficulty in walking	No	N/A	Tape, steroid injections	PBT tear excision, tubularization, PT shaping	4	No pain
Lalli et al, 2014 (15)	1	1/0	50	N/A	PBT, PLT	No	Rheumatoid arthritis, heel varus, calcaneonavicular coalition	Yes	Several years	Bilateral foot ankle pain	No	PT degeneration, edema surrounding the flexor hallucis longus, calcaneonavicular coalition	No	Calcaneal osteotomy, PT resection, brevis to longus tenodesis	3	Pain free
Celikyay et al, 2015 (27)	1	1/0	45	Excessive sports activities	PLT	No	No	Yes	N/A	Pain while walking, No fixed mass at lateral foot	No	Hypertrophic peroneal tubercle, bone edema, tenosynovitis	N/A	N/A	N/A	N/A
Palmanovich et al, 2014 (10)	2	2/0	58 60	Long distance running	PLT	No	No	Yes	N/A	Lateral foot pain	No	Hypertrophic peroneal tubercle, thickened PLT, tenosynovitis	Rest, physical therapy	PT resection, PLT repair	4	Excellent
Heller and Robinson, 2010 (21)	2	1/1	43 56	1 Fitness	PLT	Ankle sprain	Malunited lateral talar process fracture	Yes	6 3	Pain, swelling, and lack of active eversion and inversion	No	No	Physiotherapy, elastic bandage	Fragment resection	6	Some pain during inversion. Eversion 5° reduced
Boya and Pinar, 2010 (28)	1	0/1	35	No	PBT	No trauma	Pregnancy	Yes	18	Lateral ankle pain increased by eversion	No	effusion in the peroneal tendon sheath, incomplete tear of the PBT, and an enlarged peroneal tubercle	Bandage, rest, ice, NSAID	Tenosynovectomy, PBT debrided, repaired, enlarged PT removed	12	Pain free, full ROM
Sugimoto et al, 2009 (18)	3	2/1	12 45 22	Sports activity No Soccer	PLT	2× no trauma, 1× inversion sprain	No	Yes	13 12 14	Lateral ankle pain	No	N/A	NSAIDs and an injection of steroid, brace	Enlarged PT removed, sural nerve released	2 × 24, 1 × 12	No symptoms
Ochoa and Banerjee, 2007 (29)	1	0/1	16	Recreational athlete	PBT	No trauma	Previous tubercle resection	Yes	31	Recurrent foot pain	No	Increased signal PBT, tubercle edema	Tubercle resection,	PT re-resection, PBT repair	13	Excellent
Taki et al, 2007 (1)	1 (bilateral)	1/0	11	Soccer	PLT	No trauma	No	Yes	3	Lateral hindfoot pain	No	N/A	Rest, NSAIDs, ankle brace	PT resection	12	Excellent
Bruce et al, 1999 (2)	3	2/1	44 54 45	3 no	PLT	2 No, 1 twisting,	No	Yes	3, 6, 1	Lateral ankle pain	1 snapping, 2 no	N/A	Immobilization, NSAIDs, Cortisone injection	PT resection, PLT debrided and repaired	7 5 8	2 excellent, 1 minimal symptoms
Chen et al, 1998 (30)	6	2/4	29 26 24 19 26 32	no	PBT, PLT	No	No	Yes	26 32 14 14 40 37	Lateral foot pain	no.	N/A	NSAID; footwear modification	PT resection, tenosynovectomy	38 47 32 29 25 41	good
Pierson and Inglis, 1992 (31)	1	0/1	45	No	PLT	No	No	Yes	N/A	Increasing lateral foot pain, clicking, locking, giving-way	Yes	N/A	Immobilization, air splint, Cortisone injections	PT resection, retinaculum release, os peroneum resection	12	Completely resolved
Burman, 1956 (14)	1	1/0	38	No	PLT	No	Fixed equinovarus, valgus knee. Inframalleolar swelling since age of three.	Yes	1	Occasional knife-like lateral heel pain	No	N/A	No	PLT to PBT transfer, PT resection	14	Good in daily life

Abbreviations: MRI, magnetic resonance imaging; N/A, not addressed; PLT, peroneus longus tendon; PBT, peroneus brevis tendon, PT, peroneal tubercle; NSAID, nonsteroidal anti-inflammatory drug.

Table 2
Results of literature analysis for dislocation of peroneus longus tendon at the peroneal trochlea

Author(s)	n	Sex (male/female)	Age (y)	Sport	Injury	Additional Injuries/Anomalies	Peroneal Trochlea Enlarged	Preoperative History (mo)	Symptoms	Snapping	MRI	Conservative Treatment	Operative Technique	Latest Follow-Up (mo)	Result at Latest Follow-Up
Staresinic et al., 2013 (11)	3	3/0	20-28	Soccer	Ankle sprain and prolonged problems on the lateral side of the foot	Ankle sprain, direct blow	No	2.5-1-1	Swelling, hematoma, tenderness around the ankle	Yes	PLT dislocation	Rest, physiotherapy	Tubercle excision, lateral calcaneal groove formation for both peroneal tendons and IPR plasty	24	Excellent
El Rassi et al., 2012 (12)	1	0/1	23	Ice skater	No trauma, insidious	No	No	18	Pain on lateral right foot and ankle, sense of instability	Yes	Increased signal at the level of the calcaneal tubercle	Ankle brace, NSAID	IPR reconstructed with part of its superior portion.	36	Excellent
Klos et al., 2011 (13)	1	1/0	23	Soccer	Foot caught in plantar-flexion, abduction, eversion	No	No	2	Pain and swelling lateral hindfoot	Yes	No associate lesions	NSAIDs, rest, physical therapy, ankle brace	Groove deepening, suture anchor IPR	6	Excellent

Abbreviations: MRI, magnetic resonance imaging; PLT, peroneus longus tendon; PBT, peroneus brevis tendon; IPR, inferior peroneal retinaculum; NSAID, nonsteroidal anti-inflammatory drug.

calcaneonavicular coalition) were presented in the enlarged peroneal tubercle group (14,15).

Lateral foot pain was the leading symptom in both groups. Swelling and focal tenderness at the peroneal tubercle gradually increased despite conservative treatment. A snapping phenomenon was reported in 5 of 6 and 2 of 26 cases in the enlarged peroneal tubercle group and the distal dislocation group, respectively. Magnetic resonance imaging (MRI) seemed to be the imaging modality of choice to diagnose and differentiate the conditions. Initially, all published patients were treated with different conservative means, which failed in all cases. Preoperative symptoms were present for 13 (range 1 to 40) months in the enlarged peroneal tubercle group and for 2.3 (range 1 to 18) months in the distal dislocation group, respectively ($p = .04$). Tubercle resection, tenosynovectomy and, if necessary, tendon repair was performed in all cases associated with peroneal tubercle enlargement. Distal peroneal dislocations were addressed by inferior retinaculum reconstruction (6 of 6) and groove deepening (5 of 6 cases). One author additionally resected the normal-sized peroneal tubercles in his 3 dislocation cases (11).

Discussion

The most important finding of this study is that 2 different peroneal tendon pathologies can rarely occur at the peroneal tubercle, both leading to lateral heel pain and peroneal tenosynovitis. First, an enlarged peroneal tubercle seems to be the underlying cause of peroneal tendon compression, friction, longitudinal tears (split lesions), and impingement at the peroneal tubercle. Second, an even smaller group of exclusively athletic patients can injure the inferior peroneal retinaculum, leading to peroneus longus dislocation over the peroneal tubercle.

Exclusively case reports and small case series were identified. No randomized research is available so far. This limits and possibly confounds the results of systematic reviews. In contrast to a review from 2011 (4), this review demonstrates that enlargement of the peroneal tubercle can obviously lead not only to peroneal tenosynovitis but also to longitudinal (split) tears of the peroneal tendons. Previous work stated that peroneal tubercles “were larger and more frequent in middle-aged or older than younger patients” (16). It was demonstrated in 1953 that “stenosing tendovaginitis occurs mainly in heels with well-developed peroneal tubercles” (17). Our review is in line with that statement and with another review of 24 surgically treated cases (18). In an anatomic investigation, the shape of the calcaneus under the division of the peroneal tendons (peroneal tubercle) was described as flat (42.7%), prominent (29.1%), concave (27.2%), tunnel shaped (1.0%), and missing (9.6%) (9). A “significantly larger peroneal tubercle in subjects with infra-malleolar peroneal tendon abnormalities” has been described and the critical peroneal tubercle size was defined to be 4.3 mm on MRI (19).

A different pathology is evident in even more rarely cases. Exclusively athletic patients injure the inferior peroneal retinaculum, leading to peroneus longus dislocation over the normal-sized peroneal tubercle. This lesion could not be produced in an experimental setting (20). The most specific, but not constant, finding for dislocation of the peroneus longus tendon is a visible and palpable snapping (5 of 5 patients). Two patients in the enlarged peroneal tubercle group also presented with clicking and locking. These phenomena are explained by triggering an enlarged tendon into a stenotic tunnel.

A prominence at the lateral calcaneal wall can indicate an enlarged peroneal tubercle or a normal peroneal tubercle with an overlying dislocated peroneal tendon. A dislocated peroneus longus tendon was trapped in 1 case at the peroneal tubercle through an incomplete longitudinal split lesion (submitted case report). The clinical presentation was mimicking a hypertrophy of the tubercle. In the differential diagnosis of an acquired prominence of the lateral calcaneus, trauma (fracture) (21) and tumor (osteochondroma) (1,2) of the peroneal tubercle are also addressed.

Ankle sprain, chronic ankle instability, hindfoot varus, and flatfoot may play predisposing roles (3,11,14,17). Peroneal trochlea enlargement may also result from a genetic predisposition (flat or paralytic foot, equinus foot, peroneus quartus attachment) or from local friction of the footwear (1,15,22). Therefore, “hypertrophy” is probably not the correct term for all cases.

Diagnosis of the described conditions is frequently delayed. The investigator should be aware of these rare conditions. Typical findings at physical examination are swelling at the lateral calcaneus, focal tenderness over the peroneal tendons at and near to the peroneal tubercle, and a positive peroneal tendon resistance test (23).

MRI and ultrasonography can be used to confirm the diagnosis, because the imaging methods address both bony and soft tissue structure. Split lesions of the peroneal tendons, however, are not consistently detected preoperatively. MRI can be used to demonstrate marrow edema of the lateral calcaneal wall, which is induced by friction of the peroneal tendon activity (24).

Successful conservative treatment is addressed in only 1 historical report (17). In our analysis, there is no example of a patient who healed without surgery. This does not necessarily mean that there is no chance for conservative therapy. Probably, patients with “low functional demands do well with conservative treatment, while those with high functional demands may benefit from surgery if nonsurgical treatment is unsuccessful” (25).

In conclusion, we found that peroneal tendon lesions rarely occur in the area of the calcaneal tubercle. It seems that enlarged peroneal tubercles play an inducing role. In normal-sized peroneal tubercles, lesions of the inferior peroneal retinaculum can induce dislocation of the peroneus longus tendon.

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