Intrasheath Instability of the Peroneal Tendons

Dynamic Ultrasound Imaging

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Peroneal intrasheath instability is a painful snapping condition of the lateral ankle. It consists of a transient retromalleolar subluxation of the peroneal tendons without disruption of the superior peroneal retinaculum or evidence of a previous definite trauma. In type A intrasheath instability, the peroneus longus and brevis tendons are intact, and there is an intertendinous intrasheath switch. In type B intrasheath instability, the peroneus brevis tendon has a longitudinal split tear through which the peroneus longus subluxates. Both types can be missed on a physical examination because there is no displacement of the peroneal tendons over the lateral malleolus. Dynamic ultrasound is the imaging modality of choice for evaluating retromalleolar subluxation of the peroneal tendons. This review article aims to provide an overview of the anatomic basis for peroneal intrasheath instability and provide physicians with guidelines for its ultrasound assessment.

Key Words—dislocation; instability; musculoskeletal (diagnostic); peroneal tendon; subluxation; superior peroneal retinaculum; ultrasound

Recurrent peroneal instability refers to an abnormal position of the peroneal tendons at the level of the lateral malleolus. Specifically, they are normally located at rest and dislocate-subluxate during ankle motion or muscle contraction.¹ Two types of recurrent peroneal instability can be distinguished. The most known type, referred to as prefibular dislocation-subluxation, is related to a superior peroneal retinaculum injury and consists of an anterior displacement of either one or both of the peroneal tendons over the lateral malleolus.^{2–4} First described in a ballet dancer by Monteggia⁵ in 1803, it typically occurs in athletes as a result of an ankle trauma.⁶ Peroneal intrasheath instability, also known as retrofibular intrasheath subluxation, consists of an abnormal motion of the peroneal tendons relative to each other behind the lateral malleolus with no superior peroneal retinaculum disruption or previous definite trauma.^{7–9} Contrary to the previous type, peroneal intrasheath instability may be missed on a physical examination because there is no tendon displacement over the lateral malleolus. Thus, imaging is required for diagnosis. As a time-saving and largely available imaging modality that allows for dynamic and comparative examination,¹⁰ ultrasound (US) is valuable for the assessment of intrasheath instability of the peroneal tendons.

Recent literature has highlighted the role of US in the assessment of peroneal instability and in distinguishing between traumatic and nontraumatic patterns.¹¹ This review article focuses on intrasheath instability of the peroneal tendons and aims to: provide a brief overview of the anatomic basis for peroneal intrasheath instability

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Abbreviations
US, ultrasound

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and provide physicians with simple and systematic guidelines for its assessment by dynamic US. This review article was generated from the combined experience of our centers, as indicated by the references in the text, with a thorough analysis of the literature from the last 10 years (2008–2017). Real-time US videos are provided as supplementary material to make the article functional and useful in clinical practice.

Normal Anatomy

The peroneus longus and peroneus brevis muscles are located in the lateral compartment of the leg muscles.¹² The peroneus longus originates from the head and proximal two-thirds of the lateral aspect of the fibula, the anterior and posterior intermuscular septa of the leg, and the deep surface of the deep fascia and variably from the lateral tibial condyle. Its tendon passes distally behind the lateral malleolus and runs forward on the lateral aspect of the calcaneus below the peroneal tubercle. It then runs under the cuboid, crosses the sole of the foot obliquely, and inserts plantarly into the lateral aspect of the medial cuneiform and the first and second metatarsal bases. The peroneus brevis muscle belly is deeper than that of the peroneus longus. It originates from the distal two-thirds of the lateral aspect of the fibula and the anterior and posterior intermuscular septa of the leg. Its tendon runs distally behind the lateral malleolus, passes forward on the lateral aspect of the calcaneus above the peroneal tubercle, and inserts into the lateral aspect of the fifth metatarsal base.¹³

Behind the lateral malleolus, the peroneal tendons run in the peroneal retromalleolar groove with the peroneus brevis lying anterior and medial to the peroneus

longus (Figure 1). In this groove, the peroneal tendons share a common synovial sheath that splits in two at the level of the peroneal tubercle.¹³ The peroneal retromalleolar groove is converted into a tunnel by the superior peroneal retinaculum, a fibrous band extending between the posterior ridge of the lateral malleolus and the posterolateral aspect of the calcaneus, also attaching to the Achilles tendon. This osteofibrous tunnel is referred to as the superior peroneal tunnel.¹⁴ The calcaneofibular ligament provides additional stability to the peroneal tendons in the peroneal retromalleolar groove region. In the inframalleolar region, the peroneal tendons are stabilized by the inferior peroneal retinaculum, a fibrous band that is contiguous with the inferior extensor retinaculum and inserts below and into the retrotrochlear eminence on the lateral aspect of the calcaneus. The inferior peroneal retinaculum is less important than the superior peroneal retinaculum as a peroneal tendon stabilizer.^{15,16} The os peroneum can be variably found inside the peroneus longus tendon at the lateral plantar aspect of the cuboid.¹⁷

The peroneal muscles produce eversion of the foot and plantar flexion of the ankle, also acting as dynamic stabilizers of the ankle. They are both innervated by the superficial peroneal nerve.¹³

Ultrasound Examination

A US examination of the peroneal tendons is performed with the patient lying supine on the examination table, the knee joint flexed and the ankle internally rotated. The plantar portion of the peroneus longus tendon is examined on a prone patient. The peroneal tendons are assessed with a high-frequency linear array transducer

Figure 1. Normal anatomy of the peroneal tendons within the retromalleolar groove. A schematic drawing (A) and a transverse US image (B) show the peroneus brevis tendon lying anterior and medial to the peroneus longus tendon. LM indicates lateral malleolus; PB, peroneus brevis; PL, peroneus longus; and SPR, superior peroneal retinaculum.

using the grayscale mode and, eventually, Doppler imaging. A large amount of gel is recommended to accommodate the curved surface of the lateral malleolus. Both peroneal tendons are examined by orienting the transducer in the transverse plane, perpendicular to their long axes. Longitudinal-plane scans may be helpful to confirm imaging findings, such as concomitant tendon tears. Imaging is performed proximal to distal and also includes the myotendinous junctions and the distal tendon insertion sites. Healthy peroneal tendons appear as fibrillar structures due to hyperechoic collagen bundles embedded within a background of a hypoechoic matrix (Figure 1). The peroneal tendon synovial sheath can be visualized only if it is distended by fluid.^{18–20}

A dynamic assessment is crucial for evaluating peroneal intrasheath instability. It is performed with the patient lying supine on the examination table. At the level of the retromalleolar groove, the peroneal tendons are examined in the transverse plane during resisted dorsiflexion and eversion of the ankle, while avoiding excessive local pressure with the transducer. A pillow may be conveniently placed under the calf to allow free ankle movements.¹⁶

The superior and inferior peroneal retinacula are assessed in their long axes by placing the transducer in an oblique plane according to their course. The peroneal retinacula appear as thin echogenic structures (Figure 1).¹⁸ The calcaneofibular, anterior tibiofibular, and anterior talofibular ligaments should also be examined along with the peroneal tendons.²¹

Pathologic Findings

Peroneal intrasheath instability consists of a transient retromalleolar subluxation of the peroneal tendons without disruption of the superior peroneal retinaculum or evidence of a previous definite trauma.¹¹ Table 1 summarizes the clinical and US features of peroneal intrasheath instability.

Clinically, patients may have lateral ankle pain and a transient popping or snapping sensation during peroneal muscle contraction. An audible click may be evident during active dorsiflexion-eversion of the ankle, but there is no visible evidence of peroneal tendon displacement over the lateral malleolus on a physical examination.¹⁶

Two subtypes of peroneal intrasheath instability can be distinguished on US imaging according to Raikin et al.²² In both cases, the superior peroneal retinaculum is intact, and the peroneal tendons transiently reverse their anteroposterior relationship while remaining within their synovial sheath and the retromalleolar groove. In type A intrasheath instability (Figure 2 and Video 1), the peroneus longus and brevis tendons are intact, and there is an intertendinous intrasheath switch at the level of the retromalleolar groove. Specifically, the peroneus longus rotates and comes to lie deep and medial to the peroneus brevis and inversely. In type B intrasheath instability (Figure 3 and Video 2), the peroneus brevis tendon has a longitudinal split tear through which the peroneus longus subluxates, thus coming to lie deep to the peroneus brevis at this level.^{22–24} Both types of peroneal tendon subluxations usually occur during active dorsiflexion or eversion of the ankle.²²

The anatomic position of the peroneus brevis tendon within the peroneal retromalleolar groove, between the posterior fibula and the peroneus longus tendon, has been postulated to predispose it to compression and longitudinal tearing.²⁵ To date, several predisposing factors for peroneal intrasheath instability have been proposed. These include a convex or flat retromalleolar groove, a low-lying peroneus brevis muscle belly, and an accessory peroneus quartus muscle.^{26,27} They may all produce overcrowding of the superior peroneal tunnel, thus possibly increasing compressive forces and contributing to peroneal tendon disorders.²⁷

Table 1. Clinical and US Features of Type A and B Intrasheath Instability of the Peroneal Tendons

Intrasheath Instability	Clinical Findings	US Findings
Type A	No definite previous trauma Lateral ankle pain Audible popping/snapping/clicking No tendon displacement over the lateral malleolus	Intact superior peroneal retinaculum Intact peroneal tendons with relative switching of their anatomical alignment
Type B	Same as type A	Intact superior peroneal retinaculum Peroneus brevis longitudinal split Peroneus longus subluxation through the peroneus brevis split

Discussion

Peroneal intrasheath instability is not commonly reported,^{7–9,11,22,23,27–31} and, to our knowledge, its exact incidence is unknown. Based on a systematic review of

the literature over the last 10 years and taking advantage of our centers' experience, this article adds to the current literature by emphasizing the role of dynamic US in the assessment of peroneal intrasheath instability. Videos are provided as supplementary material to make the article

Figure 2. Type A peroneal intrasheath instability. A schematic drawing (A) and transverse US images (B–D) depict an intertendinous intrasheath switch at the level of the retromalleolar groove. Specifically, the peroneal tendons rotate and reverse their anteroposterior relationship. Abbreviations are as in Figure 1.

Figure 3. Type B peroneal intrasheath instability. Schematic drawings (A, C, and E) and transverse US images (B, D, and F) show a subluxation of the peroneus longus tendon through a longitudinal split tear within the peroneus brevis tendon at the level of the retromalleolar groove. The position of the peroneus longus tendon in relation to the peroneus brevis tendon is depicted during each step of the subluxation process. Abbreviations are as in Figure 1.

functional and helpful in clinical practice. The main clinical and US features of type A and B intrasheath instability of the peroneal tendons are summarized in Table 1.

Magnetic resonance imaging and computed tomography enable visualization of the peroneal tendons in relation to the retromalleolar groove.^{32–36} Magnetic resonance imaging is particularly useful to assess muscle anatomic variations as well as intratendinous abnormalities.^{34,36} However, static magnetic resonance imaging and computed tomography cannot effectively depict episodic or transient subluxation of the peroneal tendons.³⁷ Although dynamic magnetic resonance imaging can partially solve this issue,³⁸ dynamic US is the imaging modality of choice when peroneal intrasheath instability is suspected, as it has the time frame resolution needed to assess tendon displacement.³⁹ Raikin et al²² reported 100% accuracy for dynamic US to detect peroneal intrasheath subluxation with an intact superior peroneal retinaculum confirmed intraoperatively. Importantly, a US assessment of the contralateral side can be conveniently performed, as intrasheath instability of the peroneal tendons has been reported to occur in 10% of asymptomatic individuals.²⁹ Finally, in addition to the diagnosis of instability, US allows for the evaluation of peroneal tendon integrity and assessment of concomitant tears.⁴⁰

Intrasheath instability of the peroneal tendons is recalcitrant to nonsurgical management.³⁰ Surgical treatment should be aimed at restoring sufficient volume to the superior peroneal tunnel. It can be either open or tendoscopic and includes retromalleolar groove deepening, excision of the low-lying peroneus brevis muscle belly, peroneus quartus removal, and repair of associated peroneus brevis tears.^{28,30,31}

In conclusion, peroneal intrasheath instability or retrofibular intrasheath subluxation is a clinical entity not commonly reported in the literature. It should be considered in patients with painful clicking without visible displacement of the peroneal tendons over the lateral malleolus. Dynamic US is the imaging modality of choice for evaluating intrasheath subluxation of the peroneal tendons and is performed in the transverse plane during active dorsiflexion and eversion maneuvers of the ankle.

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