Imaging features of symptomatic hypertrophic tuberculum peroneum

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Purpose

Ankle pain may result from a variety of diseases. An underestimated cause of chronic lateral ankle pain is the presence of a hypertrophic tuberculum peroneum (TP). [1] As the differential diagnosis with more frequent causes of ankle pain solely based on clinical findings is often impossible, imaging is very useful for evaluation of the size of a TP and its effect on the surrounding structures.

The aim of this exhibit is to review the clinical and imaging features of symptomatic hypertrophic (TP) in a cohort of symptomatic patients.

Introduction

The TP is located on the lateral surface of the calcaneus, anteriorly to the eminentia retrotrochlearis (Fig. 1 on page 3). Anatomically, the TP has an oblique course from postero-superior to antero-inferior. The peroneus longus and brevis tendon run respectively under and above the TP, separating their tendon sheaths. It functions as fulcrum directing the peroneus longus tendon towards the cuboid. Furthermore the inferior peroneal retinaculum inserts on the TP. [2]

Its size is defined by width, height and length. Because conventional radiography (CR) is usually not accurate for precise evaluation of the size of the TP, measurements are far better performed on ultrasound (US), CT or MRI. [3] The width of the TP is the most easy parameter to evaluate on oblique coronal US images and on axial or coronal CT or MR images (Fig. 2 on page 3 and Fig. 3 on page 4). Hyer et al. [3] examined human skeletons focusing on the characteristics of the tuberculum peroneum. Their measurements revealed an average width of 3.13 mm.

Hypertrophy of the TP will cause friction and mechanical irritation which may lead to peroneal tenosynovitis causing lateral ankle pain. Anatomically, the peroneus longus tendon is at risk for tenosynovitis because of its long excursion and changing direction. The peroneus brevis tendon is less frequently affected. [4,5]

Despite multiple previous case reports and small studies, a uniform definition of a hypertrophic tuberculum peroneum is still debated. Based on those small reports a width exceeding 5 mm is considered as being hypertrophic predisposing to tenosynovitis. [6]
Images for this section:

**Fig. 1:** Lateral and superior view of the tuberculum peroneum (1) which is located anteriorly to the eminentia retrotrochlearis (2) on the calcaneus. The length (L) and height (H) are best visualized on the lateral view (sagittal). The width is the distance between the tangent line between the anterior and posterior cortex of the calcaneus and the most laterally located cortex of the TP. This parameter is easily measured on cross-sectional imaging methods.

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**Fig. 2:** Axial CR (Figure 2 b) shows a hypertrophic TP with a maximum width of 5.7 mm measured between the base and the top of the tuberculum. Oblique coronal US (Figure 2 b) confirmed the presence of a hypertrophic TP (white asterisks) with a measured width of 6 mm located between the peroneus longus (thin white arrow) and brevis (thick white arrow). Coronal CBCT (Figure 2 c) reveals a hypertrophic tuberculum peroneum in another patient with a width of 5 mm. This measurement correlated with the width measured on the oblique coronal ultrasound (Figure 2 d). Coronal PD (Figure 2 e) demonstrating measurement of the width of the hypertrophic tuberculum peroneum on MR imaging.

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**Fig. 3:** The X on the lateral side of the foot (Figure 3 a) represents the anatomical location of the TP. Figure 3 b and c show respectively the position of the ultrasound transducer in oblique coronal and oblique axial position respectively for accurate measurement of the width of the TP.

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Methods and Materials

Patients

Our study is a monocentric, retrospective cohort study of 23 patients. Inclusion criteria included referral for imaging (either US, CT or MRI; Table 1) for chronic lateral ankle pain below the lateral malleolus and a width of the tuberculum peroneum $\geq 3$ mm. Patients with underlying fracture were excluded.

Imaging protocols

Conventional radiography was performed on the AXIOM Luminos dRF (Siemens, Erlangen, Germany). AP, lateral and Mortise view are the three standard images performed of the ankle. Additional axial image to visualize the hypertrophic tuberculum was also performed. US images using Philips Health Systems EPIQ5G (Bothell, WA 98021, USA). CBCT imaging was performed on a Newtom 5G-system (QR, Verona, Italy). The field of view (8 x 8-cm) was centered on the painful ankle region. All MR examinations were performed on a 1.5T system (Siemens, Magnetom Aera, Erlangen, Germany). Routinely the following sequences were performed: sagittal, axial and coronal FS T2-WI, coronal PD and axial T1-WI with a slice thickness of 3 mm. Only seven patients underwent one type of imaging i.e. MR. The other patients had at least a combination of two imaging techniques of which the combination of MR and US was most frequent (6 patients or 26%).

Table 1: Overview of the different examinations

<table>
<thead>
<tr>
<th>Type of examination</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray</td>
<td>10</td>
</tr>
<tr>
<td>US</td>
<td>12</td>
</tr>
<tr>
<td>CBCT</td>
<td>2</td>
</tr>
<tr>
<td>MR</td>
<td>17</td>
</tr>
</tbody>
</table>

Analysis of clinical history and imaging parameters

The following parameters were retrospectively reviewed by 2 observers in consensus: history of previous ankle sprain or trauma, width of the TP on all imaging modalities, the presence and grade (I-III) of tenosynovitis of peroneus brevis (PB) and/or longus tendon (PL) (table 2), bone marrow edema (BME) at the os calcaneus.
Table 2: Tenosynovitis grading according to reference 7.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>Focal thickening of the tendon + effusion</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Partial tear</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Full tear</td>
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</tbody>
</table>
Results

Twenty three patients were included in our study, 10 men and 13 women. Eleven patients presented with right-sided chronic ankle pain while the left ankle was affected in 12 cases.

Nine patients had a history of previous ankle distortion, ranging between several months to years preceding clinical presentation. In 4 patients the request form for imaging mentioned overuse. One patient had planovalgus foot deformity.

The mean width of the TP in these symptomatic patients was 5.6 mm (range 3.6 - 8.6 mm). Isolated tenosynovitis of the peroneus longus (Fig. 4 on page 8 and Fig. 5 on page 8) was seen in 9 cases (grade 1 n=6 and grade 2 n=3). Isolated tenosynovitis of the peroneus brevis (Fig. 6 on page 9) was present in only 3 patients (grade 1 n=2 and grade 2 n=1). Concomitant involvement of both peroneal tendons (Fig. 7 on page 9 and Fig. 8 on page 10) was seen in 10 patients. (Table 3). Bone marrow edema is best detected on the FS T2-WI images and was present in 53 % (9 out of 17 patients)

Table 3: Overview of the concomitant tenosynovitis of the peroneal tendons.

<table>
<thead>
<tr>
<th>Type of concomitant tenosynovitis</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1 tenosynovitis brevis and grade 1 tenosynovitis longus</td>
<td>3</td>
</tr>
<tr>
<td>Grade 1 tenosynovitis brevis and grade 2 tenosynovitis longus</td>
<td>2</td>
</tr>
<tr>
<td>Grade 2 tenosynovitis brevis and grade 1 tenosynovitis longus</td>
<td>2</td>
</tr>
<tr>
<td>Grade 2 tenosynovitis brevis and grade 2 tenosynovitis longus</td>
<td>3</td>
</tr>
</tbody>
</table>
Fig. 4: Oblique coronal (Figure 4 a and b) and longitudinal (Figure 4 c) US. Oblique coronal US (Figure 4 a) reveals a hypertrophic TP (white asterisks) with a measured width of 6 mm located between the peroneus longus (thin white arrow) and peroneus brevis (thick white arrow). Note also surrounding effusion in the tendon sheath of the peroneus longus (white arrowhead) (Figure 4 b). On longitudinal ultrasound imaging (Figure 4 c) characteristic thickening of the peroneus longus (thin white arrow) is seen with surrounding free fluid (white arrowhead).

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Fig. 5: Coronal PD (Figure 5 a) and sagittal FS T2-WI (Figure 5 b) MR images of partial rupture of the peroneus longus tendon caused by recurrent friction. Coronal PD images visualizing the hypertrophic tuberculum peroneum (asterisk). Focal thickening of the peroneus longus with partial rupture of the tendon, grade 2 tenosynovitis (thin white arrow) on the sagittal FS T2-WI. Note also subtle bone marrow edema at the calcaneus (white arrowhead).
Fig. 6: Sagittal (Figure 6 a) and axial (Figure 6 b) FS T2-WI MR images showing impingement of the infra-malleolar part of the peroneus brevis tendon with focal peroneal split (thin white arrow) and surrounding effusion (white arrowhead).

Fig. 7: The hypertrophic tuberculum peroneum is measured on the axial T1-weighted images (Figure 7 a) and has a width of 6.4 mm. There is a focal thickening of the peroneus longus tendon (thin white arrow) with increased signal and effusion on the sagittal (Figure 7 b) and coronal (Figure 7 c) FS T2-WI MR images. Note also increased fluid within
the tendon sheath of the peroneus brevis (thick white arrow) in keeping with mechanical friction.

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**Fig. 8**: Oblique coronal (Figure 8 a, b and c) and oblique axial (Figure 8 d) US. Oblique coronal ultrasound (Figure 8 a) shows a hypertrophic TP with a width of 5 mm. Increased Power Doppler flow signal (curved white arrow) is seen at the periphery peroneus longus tendon (thin white arrow) with adjacent fluid effusion (white arrowhead), in keeping with tenosynovitis grade 1 (Figure 8 b). Ongoing friction results in a longitudinal cleft in the inframalleolar peroneus brevis (thick white arrow) as seen on the oblique coronal (Figure 8 c) and oblique axial (Figure 8 d) ultrasound images of the peroneal tendons with central anechogenicity (white asterisks) and increase in the peripheral Doppler flow signals (curved white arrow).

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Conclusion

• Hypertrophic tuberculum peroneum is an underestimated cause of chronic ankle pain following previous ankle sprain and should be considered in the differential diagnosis of other causes of lateral ankle pain.
• An advantage of US in comparison to the other modalities is the dynamic aspect of the examination along with the ability to correlate with the location of the pain of the patient.
• The mean width of the TP in our series (5.6 mm) of symptomatic cases is larger than in the literature (3.13 mm). A uniform definition of hypertrophic TP is lacking but a width of # 5 mm is considered hypertrophic predisposing for tenosynovitis of the peronei.
• Involvement of the peroneus longus is more common than isolated involvement of the peroneus brevis. Often, there is concomitant involvement of both peronei (43%). Tenosynovitis grade 1 is most common.
• Axial FS T2-WI are the best sequences to detect associated bone marrow edema, which was present in 53 % of our series.
References

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