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REVIEW ARTICLE

High-resolution ultrasound of the fascia lata iliac crest attachment: anatomy, pathology, and image-guided treatment

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Abstract

Pathology of the fascia lata attachment at the iliac crest (FLAIC) is an under-recognized and often misdiagnosed cause of lateral hip pain. The fascia lata has a broad attachment at the lateral iliac crest with contributions from the tensor fascia lata muscle, the iliotibial band, and the gluteal aponeurosis. The FLAIC is susceptible to overuse injuries, acute traumatic injuries, and degeneration. There is a paucity of literature regarding imaging and image-guided treatment of the FLAIC. We review anatomy and pathology of the FLAIC, presenting novel high-resolution (18–24 MHz) ultrasound images including ultrasound guidance for targeted therapeutic treatment.

Keywords Fascia lata · Iliotibial band · Tensor fascia lata · Gluteal aponeurosis · Ultrasound

Introduction

The fascia lata, or the deep fascia enveloping the musculature of the thigh, is an intricate anatomical structure with multiple components. Comprised of an expansive network of fibrous tissue, the fascia lata extends throughout the buttocks, hip, and thigh. Along the lateral iliac crest, the fascia lata has a broad attachment with contributions from the tensor fascia lata muscle, the iliotibial band, and the gluteal aponeurosis. Pathology of the fascia lata attachment at the iliac crest (FLAIC) can present with acute or chronic lateral hip pain and/or anterior groin pain [1–3]. Unfortunately, FLAIC pathology is often under-recognized and misdiagnosed, which can lead to delayed diagnosis and treatment as well as potential unnecessary imaging and misdirected intervention [1, 4–6].

There is limited information regarding the FLAIC within the literature, particularly in regard to high-resolution ultrasound and image-guided therapeutic interventions. Furthermore, there are variable, and at times conflicting, descriptions of the complex anatomy and nomenclature of the fascia lata and its contributions [1, 7]. Several recent papers have described the imaging features of FLAIC components. A 2002 paper by Bass et al. described the sonographic appearance of the proximal attachment of the tensor fascia lata, a component of the FLAIC, with 5–12-MHz ultrasound [2]. Pathology and magnetic resonance imaging (MRI) of the proximal iliotibial band, a component of the FLAIC, was described in a 2011 paper by Sher et al. [4]. A comprehensive paper by Huang et al. in 2013 analyzed in detail the anatomy of the gluteal aponeurotic fascia and proximal iliotibial band, based on dissection of 40 cadaveric specimens, and reviewed MRI findings [1]. To our knowledge, high-resolution ultrasound of the FLAIC has not been previously described in the literature.

We present an overview of the anatomy and normal high-resolution sonographic appearance of the fascia lata attachment at the iliac crest as well as ultrasound findings of FLAIC pathology with MRI correlation. We also present our experience with ultrasound guided therapeutic injections of the FLAIC.

Anatomy and sonographic appearance

The fascia lata is a complex anatomical structure composed of fibrous tissue investing the thigh musculature with multiple contributions and pelvic attachments [1, 8]. Anatomic depictions and nomenclature are variable within the literature, and for this reason, we have provided a simplified portrayal of the FLAIC anatomy (Fig. 1):

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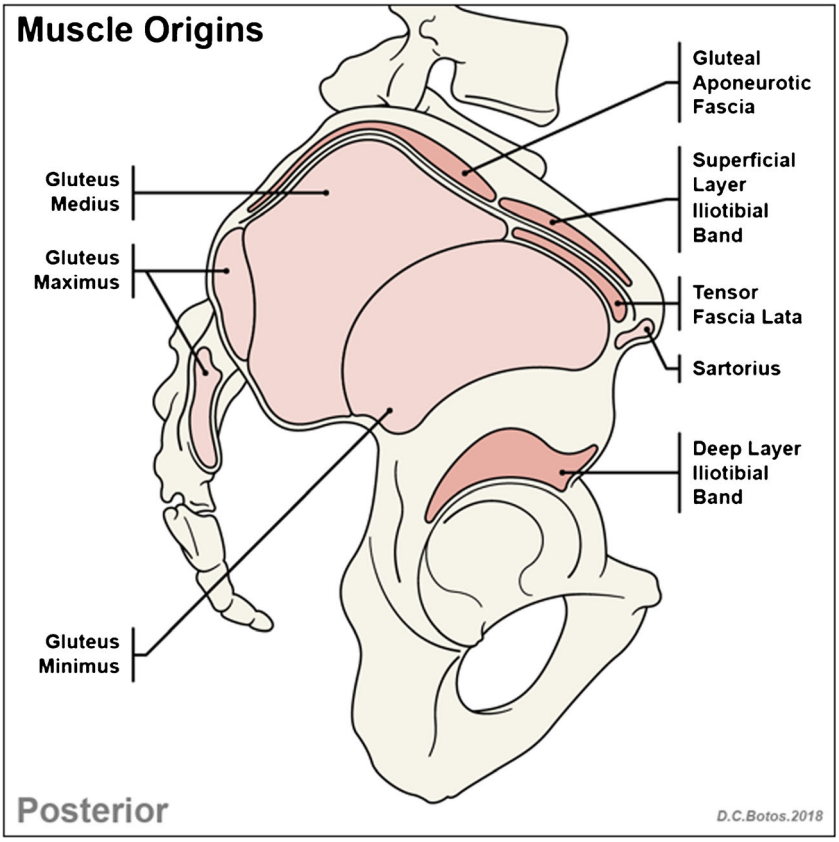

Fig. 1 Illustration depicting the anatomy of the FLAIC. Original artwork by David Botos

Along the upper lateral thigh, the fascia lata merges with contributions from the tensor fascia lata, the iliotibial band, and the gluteal aponeurotic fascia to form the FLAIC. The tensor fascia lata component comprises the anterior-most margin of the FLAIC, attaching at the anterior lip of the iliac crest. The tensor fascia lata is a muscle with characteristic fat deposition separating myofibrils that functions to abduct and internally rotate the thigh. The iliotibial band, a strong tri-layered fascial structure unique to humans, contributes its superficial fascial layer to the FLAIC. The iliotibial band, also known as Maissiat's band, serves as the distal extension of the tensor fascia lata muscle to aid in abduction, extension, and lateral rotation of the hip as well as in knee stabilization. The superficial fascial layer of the iliotibial band attaches at the iliac tubercle, a bony protuberance along the outer lip of the iliac crest, and courses over the tensor fascia lata. The intermediate fascial layer of the iliotibial band merges with the superficial layer along the inferior margin of the tensor fascia lata muscle and subsequently merges with the deep fascial layer further distally. The gluteus maximus muscle contributes tendinous fibers along the posterior margin of the iliotibial band, thereby functioning as a tensor of the fascia lata. The gluteal aponeurotic fascia, which covers the gluteus medius, forms the posterior component of the FLAIC, and attaches along the posterior outer lip of the iliac crest. Fibers of the gluteal aponeurotic fascia also contribute directly to the posterior margin of the iliotibial band [1, 2, 7, 9].

The anatomy of the FLAIC can be appreciated on routine MRI of the pelvis, or MRI of the hip if the field of view is large enough to capture the iliac crest (Fig. 2). At the authors' institution, large field of view coronal T1-weighted and fluid-sensitive fat-saturated images are included in the standard MRI hip protocol.

High-resolution ultrasound can readily depict the components of the FLAIC (Fig. 3). The tensor fascia lata attachment along the anterior margin of the lateral iliac crest can be identified by scanning along the course of the tensor fascia lata muscle. The tensor fascia lata muscle is readily identified by its location along the anterolateral aspect of the upper thigh and by its unique echotexture due to internal fat content, which is more prominent within the distal muscle. The superficial layer of the iliotibial band can be seen coursing superficial to the tensor fascia lata muscle in the thigh and attaching at the iliac tubercle. It can be identified distally by localizing the iliotibial tract at its insertion on Gerdy's tubercle at the knee. The iliotibial band attachment at the iliac crest is relatively hyperechoic and demonstrates a fibrillar pattern with a thick attachment site [7]. More posteriorly along the lateral iliac crest, the gluteal contributions to the FLAIC are identified as a relatively hyperechoic, slightly thinner attachment.

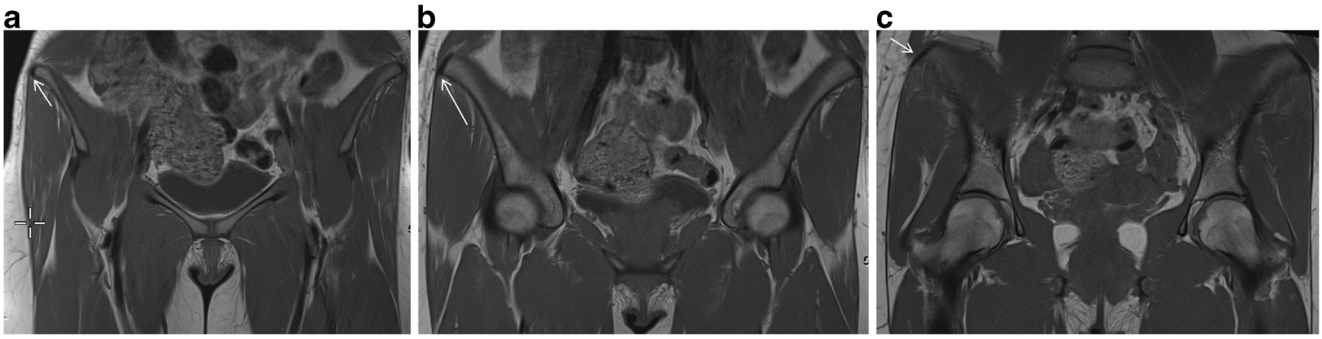

Fig. 2 Coronal T1-weighted MRI demonstrates normal anatomy of the FLAIC in a 27-year-old female. **a** The attachment of the tensor fascia lata and the overlying superficial layer of the iliotibial band are seen along the anterior lip of the iliac crest (*arrow*). The *cursor* marks the fascia lata muscle. **b** Slightly more posteriorly, the thick attachment of the iliotibial band is seen at the iliac tubercle (*arrow*). **c** Further posteriorly, the gluteal contribution to the iliotibial band and FLAIC is visualized (*arrow*)

Pathology/clinical presentation

There is limited literature regarding pathology of the FLAIC and its individual components. The FLAIC is susceptible to low-grade, partial-thickness, or full-thickness tearing as well as chronic changes such as scar remodeling and thickening. Mechanisms of potential FLAIC injury includes overuse injuries in athletes, acute traumatic injury, degenerative patterns of injury, and inflammatory pathology [1].

Overuse injuries in athletes include "proximal iliotibial band syndrome", coined by Sher et al. and initially described as proximal iliotibial band strain [4]. Sher et al. noted that the syndrome typically occurs in women, either female athletes or older overweight females [4]. Runners in particular are often susceptible to overuse injuries [5]. Chronic, repetitive microtrauma of the FLAIC can lead to enthesopathy, with marrow edema of the iliac tubercle and FLAIC thickening [1]. Traumatic tearing of the FLAIC can occur in the setting of sports, motor vehicle accidents, or falls. Given the high-grade nature of traumatic FLAIC injuries, evaluation for muscular herniation through the fascial defect should be performed [1]. Iliotibial band rupture after stretching has been reported in the setting of chronic oral steroid use [6]. Degenerative patterns of injury of the FLAIC typically occur in middle-aged and elderly females. Concurrent FLAIC pathology can also

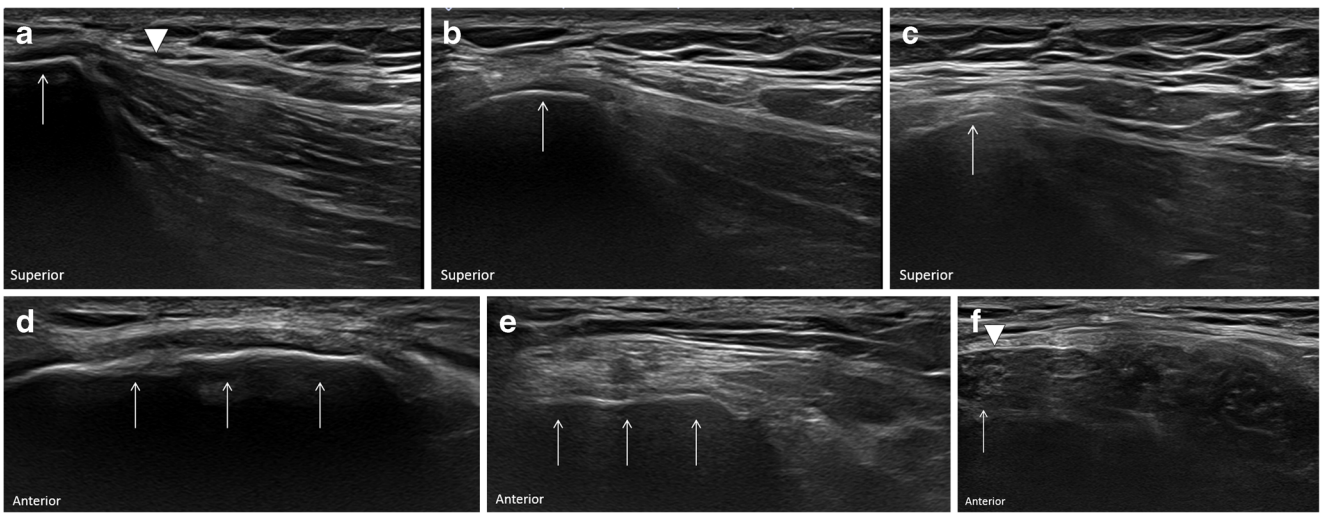

Fig. 3 A 33-year-old asymptomatic male volunteer. **a**–**c** High-resolution ultrasound (24-MHz transducer) demonstrates normal anatomy of the FLAIC in the longitudinal plane. *Left* of image is superior or cranial orientation relative to the patient. **a**, **b** The tensor fascia lata attaches along the anterior outer lip of the iliac crest (*arrow*) with the superficial layer of the iliotibial band (*arrowhead*) seen coursing superficial to the tensor fascia lata and attaching at the iliac crest. **b** Slightly more posteriorly, the superficial layer of the iliotibial band demonstrates a thick attachment at the iliac tubercle (*arrow*). **c** Further posteriorly, the gluteal aponeurotic fascia merges with the posterior margin of the iliotibial band to attach on the posterior outer lip of the iliac crest (*arrow*). **d**–**f** Transaxial high-resolution ultrasound (24-MHz transducer) demonstrates the **d** anterior and **e** posterior components of the FLAIC (*arrows*). Left of image is anterior orientation relative to the patient. **f** More distally, transaxial high-resolution ultrasound (24-MHz transducer) demonstrates the superficial layer of the iliotibial band (*arrowhead*) coursing over the tensor fascia lata muscle (*arrow*). Note the unique tensor fascia lata echotexture due to internal fat deposition separating the myofibrils

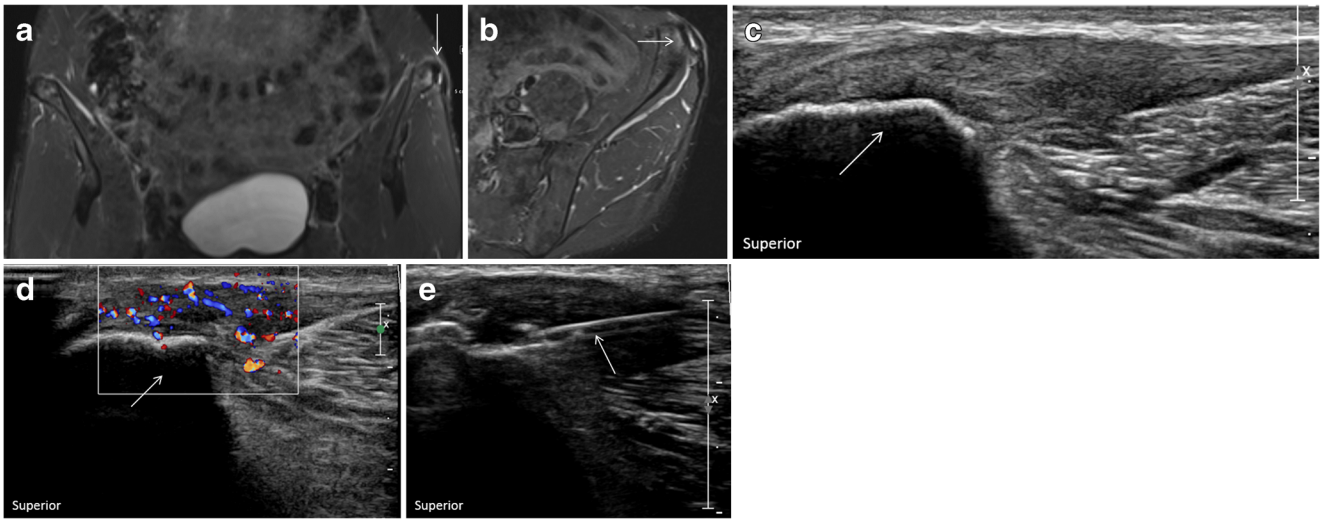

Fig. 4 A 52-year-old female runner with left hip pain and tenderness along the medial margin of the iliac tubercle on physical exam. MRI was initially obtained. **a** Coronal and **b** axial STIR images demonstrate a high-grade partial-thickness tear of the FLAIC with associated bone marrow edema pattern within the iliac crest (*arrow*). **c** Longitudinal ultrasound demonstrates marked thickening and partial thickness tearing of the FLAIC (*arrow*) with **d** associated hyperemia on Doppler imaging (*arrow*). **e** Ultrasound-guided steroid injection and dry needling was performed with visualization of the needle tip (*arrow*). The patient reported significant improvement on 1-week follow-up with her clinician

occur in the setting of chronic greater trochanteric pain syndrome [1].

Pathology of the FLAIC or its individual components typically presents with pain over the lateral iliac crest [1, 4]. Anterior groin pain secondary to tensor fascia lata insertional tendinopathy has also been reported [2]. In cases of trauma, an audible "pop" may be recounted by the patient and overlying swelling and ecchymosis may be observed on physical exam [1]. Although there is generally an absence of symptoms and physical exam findings indicating internal hip derangement, FLAIC pathology is often misdiagnosed initially and can lead to unnecessary hip imaging and treatments including physical therapy and hip injections [1, 4]. While there are a variety of potential etiologies of lateral hip pain [3, 10], injury of the FLAIC or one of its components should be included in the differential diagnosis.

Imaging

Imaging findings of FLAIC pathology include scar remodeling, perifascial edema, and partial-thickness or full-thickness tears.

On MRI, scar remodeling of the FLAIC is visualized as thickening and hypointensity of the fascia lata attachment at the iliac crest or its individual components. Increased surrounding signal intensity on fluid-sensitive sequences is compatible with perifascial edema, whereas intrinsic signal hyperintensity corresponding to fluid is compatible with a tear. Bone marrow edema pattern within the iliac tubercle may be present (Fig. 4a and b). In patients who have sustained recent trauma, edema of the gluteal musculature may be noted [1].

On high-resolution ultrasound, scar remodeling is visualized as thickening and hypoechogenicity of the fascia lata

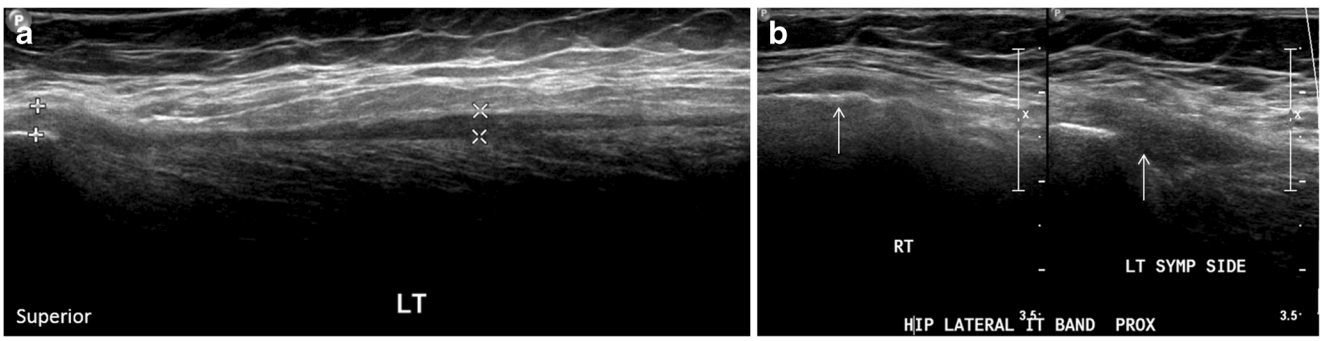

Fig. 5 A 45-year-old female with left hip pain. **a** Longitudinal ultrasound demonstrates diffuse thickening and irregularity of the proximal iliotibial band, corresponding to the site of the patients' pain as elicited by application of transducer pressure over the proximal attachment. **b** Contralateral longitudinal ultrasound demonstrates normal appearance of the right proximal iliotibial band attachment, as compared to the thickened hypoechoic left proximal iliotibial band attachment (*arrows*)

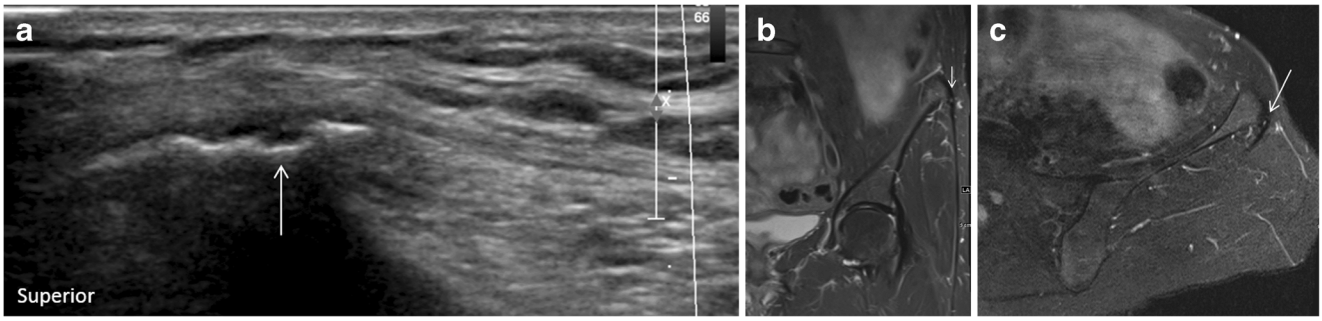

Fig. 6 A 59-year-old female with left hip pain. **a** Longitudinal ultrasound demonstrates small partial thickness tears within the left gluteal contribution to the FLAIC. Linear mineralization at the iliac crest is compatible with enthesopathic mineralization from chronic overuse. **b** Coronal and **c** axial STIR MRI demonstrates subtle fluid signal defects compatible with partial thickness tears within the left FLAIC (*arrows*)

attachment with loss of normal fibrillary echotexture (Fig. 5). Perifascial edema can be identified on high-resolution ultrasound as ill-defined surrounding soft tissue hypoechogenicity, with or without evidence of hyperemia on color/power Doppler ultrasound (Fig. 4c and d). A tear of the FLAIC appears as an intrasubstance anechoic cleft, which may involve any, or all, of the components of the FLAIC (Fig. 6). Thorough ultrasound from anterior to posterior along the FLAIC is therefore crucial. Lastly, bony changes to the underlying iliac crest/iliac tubercle may be appreciated, including cortical irregularity, enthesopathic mineralization (Fig. 6), and osseous spur formation [2]. To our knowledge, symptomatic calcium hydroxyapatite deposition in this location has not been described, but commonly occurs around the hip and could be considered as well.

While an advantage of MRI is global assessment of the pelvis/hip in nonspecific clinical scenarios, targeted ultrasound can be used to assess the FLAIC directly in cases of high clinical suspicion of FLAIC pathology. Since ultrasound is operator-dependent, all cases of suspected FLAIC pathology are performed by sonographers or sonologists specialized in musculoskeletal ultrasound at the authors' institution. Advantages of ultrasound include cost-effectiveness, ease of accessibility, and patient-directed examination (Fig. 7). Ultrasound is relatively fast and can include dynamic and contralateral imaging if necessary for interpretation [2, 7]. In our experience, the presence or absence of tenderness upon application of transducer pressure (sonopressure) over the FLAIC can provide clinically useful diagnostic information. Furthermore, ultrasound can be used to guide targeted treatment injection.

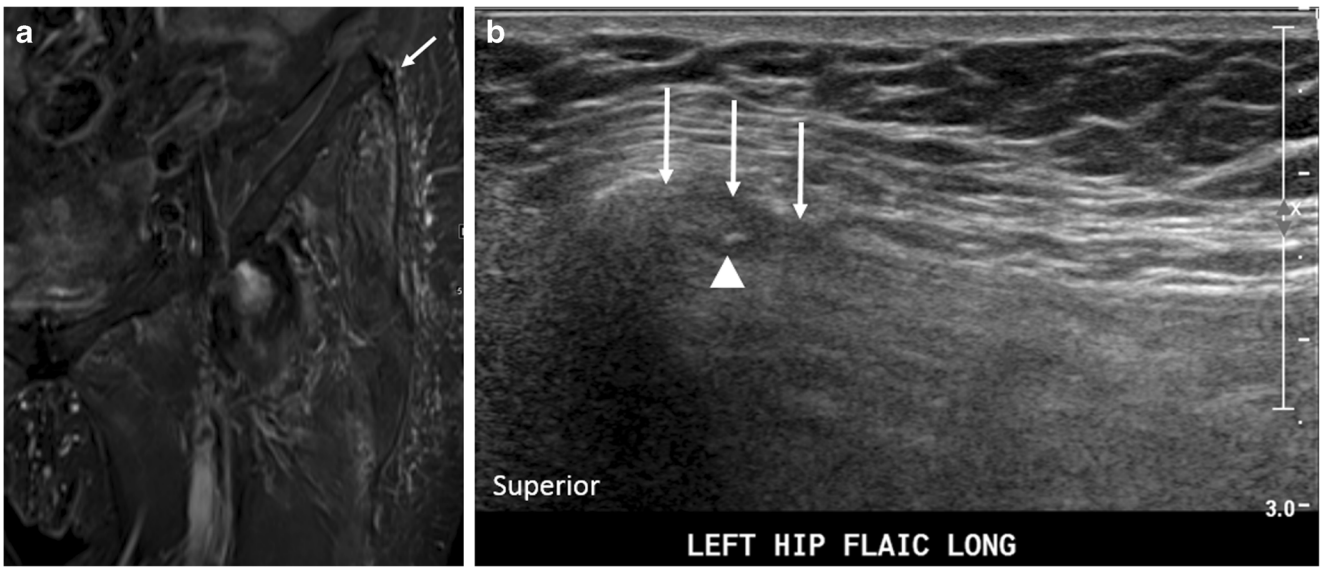

Fig. 7 A 90-year-old female with left hip pain who underwent a non-image-guided injection by a clinician at an unspecified location in the region of her left hip. She subsequently presented to her primary care physician with concern for pain at the injection site. The clinician ordered an MRI of the left hip to rule out soft tissue infection at the unspecified injection site. **a** Thickening, partial-thickness tearing, and mild edema of the left FLAIC was incidentally noted on coronal STIR MRI (*arrow*). MRI demonstrated no evidence of infection, although the soft tissues were not entirely included in the field of view due to body habitus. Ultrasound was therefore recommended. The patient returned for ultrasound and pointed directly to her left lateral iliac crest as the site of her pain. **b** Ultrasound of the area of concern localized to the FLAIC and demonstrated high-grade partial-thickness tearing with foci of enthesopathic mineralization

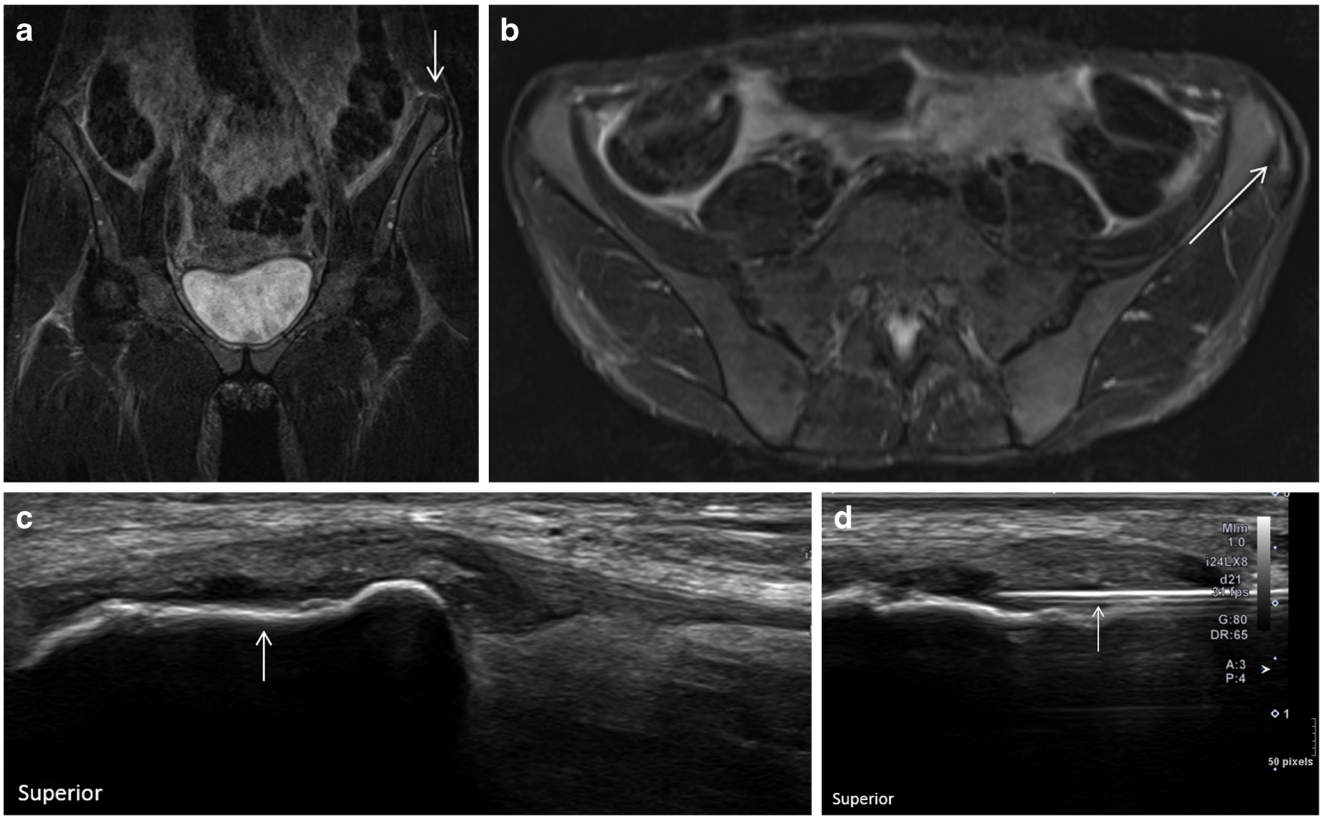

Fig. 8 A 27-year-old female competitive marathon runner with left hip pain for several months. Physical exam demonstrated mild tenderness to palpation over the anterior left iliac crest. MRI was initially obtained. **a** Coronal and **b** axial STIR MR images demonstrate scarring and partial-thickness tear of the left FLAIC (*arrow*). **c** Longitudinal high-resolution ultrasound demonstrated a partial-thickness tear and thickening of the tensor fascia lata and proximal iliotibal band components of the FLAIC (*arrow*). **d** Ultrasound-guided steroid injection and dry needling was performed, with direct visualization of the needle tip (*arrow*). The patient reported excellent 100% symptom relief 1 week after the procedure

Treatment

There is limited research regarding treatment of FLAIC pathology. Conservative treatment strategies for injury of the FLAIC and its components include rest, anti-inflammatory medications, and physical therapy [7]. Cortisone injections, platelet-rich plasma injections, and surgery are potential options for refractory pain [1, 2, 6]. Clinicians often perform these injections blindly by using the site of maximal symptoms to guide needle placement.

Although there is limited published information regarding ultrasound-guided FLAIC corticosteroid injections, ultrasound-guided interventions in the musculoskeletal system are generally well established [11–14]. At the authors' institution, ultrasound-guided corticosteroid injections are routinely performed for various indications, including joint injections, peritendinous injections, perineural injections, Morton neuroma injections, and plantar fascia origin injections. Similarity between FLAIC and plantar fascia enthesopathy has previously been noted by Huang et al. [1] with substantial literature regarding ultrasound-guided plantar fascia interventions [15, 16].

In our experience, ultrasound serves as an excellent tool for visualization and needle guidance for corticosteroid injection of FLAIC pathology (Figs. 4e and 8d). The use of ultrasound guidance allows precise corticosteroid injection at the exact area of pathology, which may involve any component of the FLAIC. Our methodology includes administration of regional anesthesia with 1% lidocaine and injection of 1 ml of Kenalog (40 mg/ml) and 1–3 cc of 1% lidocaine through a 20–22 gauge spinal needle at the area of pathology. Our suggestion is to place the needle tip deep to the FLAIC, rather than within the substance of the FLAIC, to decrease potential risk of rupture. Placing the needle tip superficial to the FLAIC has the potential to miss the primary pain generator and carries risk of subcutaneous fat atrophy. Concurrent dry needling may also be helpful in augmenting the healing response. Two cases of ultrasound-guided percutaneous needle tenotomy for chronic tensor fascia lata tendinopathy have recently been reported [17]. Our methodology for dry needling entails multiple passes with a 20–22-gauge spinal needle through the FLAIC extending to the iliac crest enthesis, prior to steroid injection. We have observed successful pain relief reported by our

patients on 1-week follow-up after ultrasound-guided FLAIC corticosteroid injection (Figs. 4 and 8).

Conclusions

High-resolution ultrasound is an excellent imaging modality for rapid, targeted visualization, evaluation, and potential treatment guidance of the FLAIC. Pathology of the FLAIC and its individual components is an under-recognized etiology of lateral hip pain, with limited available literature. While the anatomy of the FLAIC and its components is complex with variable descriptions in the literature, pathology in the region of the iliac crest can readily be identified by radiologists if included in the field of view on MRI or if scanned on ultrasound. Further research is needed regarding ultrasound findings of the FLAIC and ultrasound-guided FLAIC interventions. General awareness of the FLAIC and potential pathology is crucial to accurately guide imaging recommendations and management decisions.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

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