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SCIENTIFIC ARTICLE

Ultrasound-guided injection for the diagnosis and treatment of posteromedial knee friction syndrome

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Abstract

Objective To describe an ultrasound guided injection technique for diagnosing and treating posteromedial knee friction syndrome, which occurs between the sartorius/gracilis tendons and medial femoral condyle (MFC).

Materials and methods Our study was IRB-approved and HIPAA-compliant. We identified patients via a retrospective review of medical records and MRI with posteromedial knee pain and isolated edema between MFC and sartorius/gracilis tendons and no evidence for meniscal tear, ruptured Baker's cyst or degenerative joint disease. Patients were referred for an ultrasound-guided procedure to inject anesthetic and corticosteroid at the site of edema. Procedures were evaluated for technical success, which was defined as satisfactory identification of the injection site and adequate delivery of medication. Follow-up was available up to 8 weeks after the procedure to determine the response and any potential complications.

Results Fourteen subjects with MRI and symptoms of posteromedial knee friction syndrome underwent 14 injections. Technical success was achieved in all procedures, with no complications. At 8 weeks' follow-up, 92% of patients had symptom improvement. VAS before and 8 weeks after the procedure changed from 5.2 ± 2.7 to 0.9 ± 2.1 ($p = 0.0002$), respectively.

Conclusion Ultrasound-guided injection of edema between the MFC and sartorius/gracilis tendons supports the diagnosis of a posteromedial knee friction syndrome and successfully treats its associated symptoms.

Keywords Knee · Gracilis · Sartorius · Femoral condyle · MR imaging · Friction syndrome

Introduction

Abnormal motion of knee tendons in relation to osseous structures can be a source of pain. Iliotibial band [1] and patellar tendon–lateral femoral condyle [2–4] friction syndromes have been described in the literature, and manifest on MRI as edema in soft tissues located between tendon and bone [1, 2]. Although these entities affect the lateral knee, less common medial knee friction syndromes have been described, such as between semitendinosus and medial tibial condyle [5], gracilis, and semitendinosus versus semimembranosus tendon [6], and tibial collateral ligament over tibial crest [7].

More recently, abnormal motion between the sartorius and medial femoral condyle (MFC) was described using ultrasound [8]. Further, in a study using MRI, an entity consisting of soft-tissue edema deep to sartorius and gracilis tendons was described in subjects with posteromedial knee pain, showing no evidence for concurrent posteromedial pathological knee condition (Fig. 1) [9]. This novel entity was defined as posteromedial knee friction syndrome [9], being more common in physically active young adult women. Two subjects in this cohort underwent ultrasound-guided injection of a mixture of anesthetic and corticosteroid targeted to the area of edema, with substantial immediate pain relief [9]. However, longer follow-up time was not available and information on pre-procedural clinical features was limited.

In this study, we report our experience in a series of ultrasound-guided injections in subjects with pain and MRI suggestive of posteromedial knee friction syndrome, followed for up to 8 weeks after the procedure.

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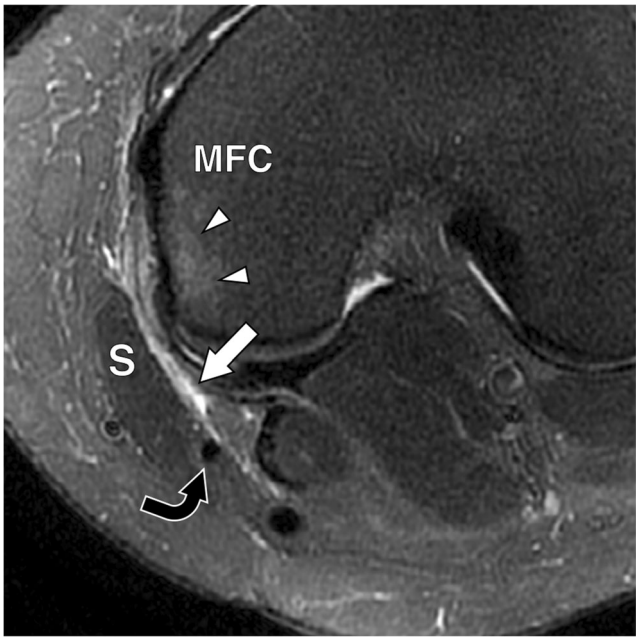

Fig. 1 A 47-year-old woman with medial knee pain. Axial T2FS MRI shows findings of posteromedial knee friction syndrome, including severe soft-tissue edema (*arrow*) deep to the sartorius (*S*) and gracilis (*curved arrow*). Edema in the medial femoral condyle (*MFC*) is also noted (*arrowheads*)

Materials and methods

Subject selection and clinical information

This retrospective study was approved by the Institutional Review Board (IRB) and complied with Health Insurance Portability and Accountability Act (HIPAA) guidelines, with exemption status for individual informed consent.

Between February 2015 and April 2018, patients with posteromedial knee pain and MRI showing edema consistent with posteromedial knee friction syndrome were referred to our interventional service for ultrasound-guided injection targeting the abnormality. Subjects were triaged by discussion between clinicians and radiologists based on the described criteria [9], which included an absence of a medial meniscal tear, ruptured Baker's cyst, pes anserine bursitis, acute injury to tibial collateral or posterior oblique ligament, and osteoarthritis of medial femorotibial compartment. Knee MRI comprised a combination of pulse sequences performed on 1.5-T and 3.0-T scanners (General Electric Medical Systems, Waukesha, WI, USA; Siemens Medical, Erlangen, Germany) using dedicated quadrature knee coils that included sagittal and coronal T2-weighted fat-suppressed (T2FS) fast spin echo (FSE; TR/TE, 4,100–3,550/42–48 ms; number of excitations [NEX], 1; matrix, 320 × 228; slice thickness, 3–4 mm; field-of-view [FOV], 18 cm); axial T2FS FSE (4,200/50 ms; NEX, 2; 512 × 384, 3 mm; 17 cm); sagittal proton density (PD) FSE (2,200/24 ms; NEX, 1; 320 × 320; 3 mm; 18 cm); and coronal T1-weighted (600/15 ms; NEX, 1; 448 × 384; 4 mm; 18 cm) pulse sequences.

Medical records were reviewed for clinical and surgical notes. Clinical data included age, gender, side, symptoms, knee physical examination, and management notes. Clinical notes at presentation and follow-up visits were reviewed on medical records and relevant history with physical examination data were recorded. Post-procedural follow-up notes up to 8 weeks were tabulated as per clinical protocol and used for analyses.

As previously described [9], edema among the MFC, sartorius, and gracilis was defined as fluid-like increased SI on T2FS axial images and graded as mild (soft-tissue edema or laminar fluid <2 mm in thickness and not >2× the diameter of gracilis); moderate (soft-tissue edema or laminar fluid >2 mm in thickness and > 2× the diameter of gracilis); or severe (findings similar to moderate, with MFC marrow edema affecting nonweightbearing area). This qualitative assessment was tabulated by consensus among two fellowship trained musculoskeletal radiologists, with 6 and 21 years of experience. Further, the smallest distance between the lateral surface of the sartorius and gracilis relative to MFC was measured independently by both radiologists using OsiriX software version 5.8 (http://www.osirix-viewer.com/index.html) and averaged for statistical analyses.

Pre-procedural physical examination and dynamic ultrasound of posteromedial knee

At arrival, the patient was asked to quantify the severity of the symptoms using a visual analog scale (VAS) ranging from 0 (no pain) to 10 (worst pain). Before ultrasound examination, a physical examination was performed by one of the investigators in all subjects. The examination consisted of the McMurray test on the affected knee, which is performed with the patient supine. The hip and knee are flexed and the examiner places one hand on the medial or lateral joint line, and the other hand holds the patient's heel. Initially, varus stress to the knee is applied with internal leg rotation while extending the knee. A palpable click or pain in the varus/internal rotation position is considered positive for lateral meniscal tear. The knee is cycled back to flexion, then valgus stress and external rotation are applied to the knee with subsequent extension. A palpable click or pain in the valgus/external rotation position is considered positive for a medial meniscal tear. The patient's pain or other symptoms elicited during the McMurray test were recorded.

A preliminary ultrasound evaluation was performed using a Logiq S8 ultrasound unit (GE Healthcare, Waukesha, WI, USA) with a multi-frequency (10–14.0 MHz) linear transducer. One or two focal zones were used and centered on the appropriate anatomical structures. We performed a dynamic ultrasound examination with passive knee flexion and

extension to evaluate for abnormal tendon motion about the posteromedial knee (Video 1 and Video 2). Patients were examined in the prone position with varying amounts of varus or valgus stress and internal or external rotation of the leg to attempt to accentuate the motion of tendons around the knee.

Injection technique

Injections were performed with the patient lying prone and the knee extended. The ultrasound probe was placed at the posteromedial knee, transverse to the lower limb, to identify the medial femoral condyle and cross-section of sartorius and gracilis tendons (Fig. 2). A skin mark with indelible ink was made adjacent to the posterior footprint of the transducer. A posterolateral-to-anteromedial needle trajectory was used for all cases.

A mixture of triamcinolone (1 mL, Kenalog® 40 mg/mL) and lidocaine 1% (2 mL) was prepared in a 3-mL syringe connected to a 25-gauge 1.5-in needle via injection tubing. For all injections, the skin surrounding the needle entry point was cleaned using chlorhexidine solution and sterile drapes were placed. The ultrasound transducer was protected with a sterile cover containing a small amount of sterile gel. Approximately 1 mL of lidocaine 1% was injected subcutaneously at the needle entry point. All injections were accomplished using a free-hand technique and performed by one of the investigators. The radiologist oriented the needle on-axis to the transducer's imaging plane and angled approximately 45° to the skin surface. The needle was advanced with intermittent back-and-forth movements to identify its tip. Once the needle tip was between the MFC and sartorius/gracilis tendons, medication was injected under real-time monitoring (Fig. 3, Videos 1, 2). Spread of medication throughout the area of edema was obtained by initially placing the needle deep to the sartorius, then retracting mildly to obtain distribution under the gracilis (Videos 1, 2). The needle was removed after the full volume was injected. The skin was cleaned, and a sterile bandage placed at the puncture site.

Technical success was defined as satisfactory identification of the target area, appropriate needle placement, and delivery of medication. Immediately after the injection, the McMurray test was repeated on the procedure table and the patient's change in symptomology was recorded. The patient was also

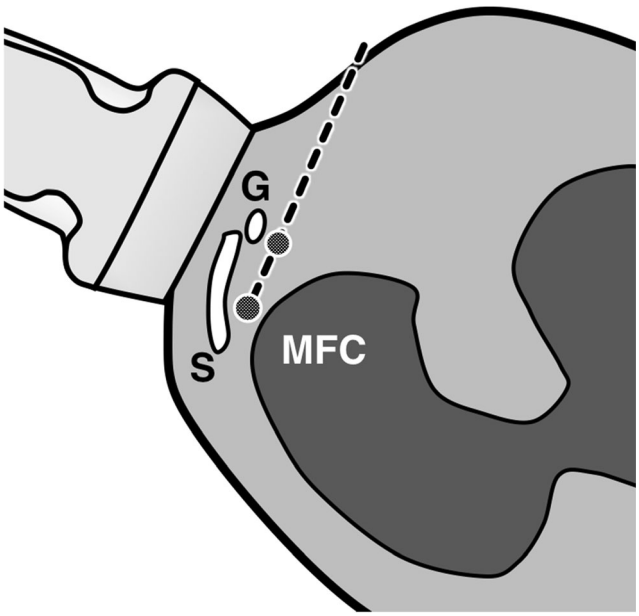

Fig. 2 Illustration showing the approach for the injection of space between the MFC and sartorius/gracilis with the patient in a prone position. The ultrasound probe is placed transverse to the lower extremity to image the sartorius and gracilis cross-sections. A posterolateral-to-anteromedial path along the *dashed line* aimed to place the needle tip deep to the sartorius (*S*) and gracilis (*G*) tendons. The preferential areas for medication delivery are shown as *patterned circles*

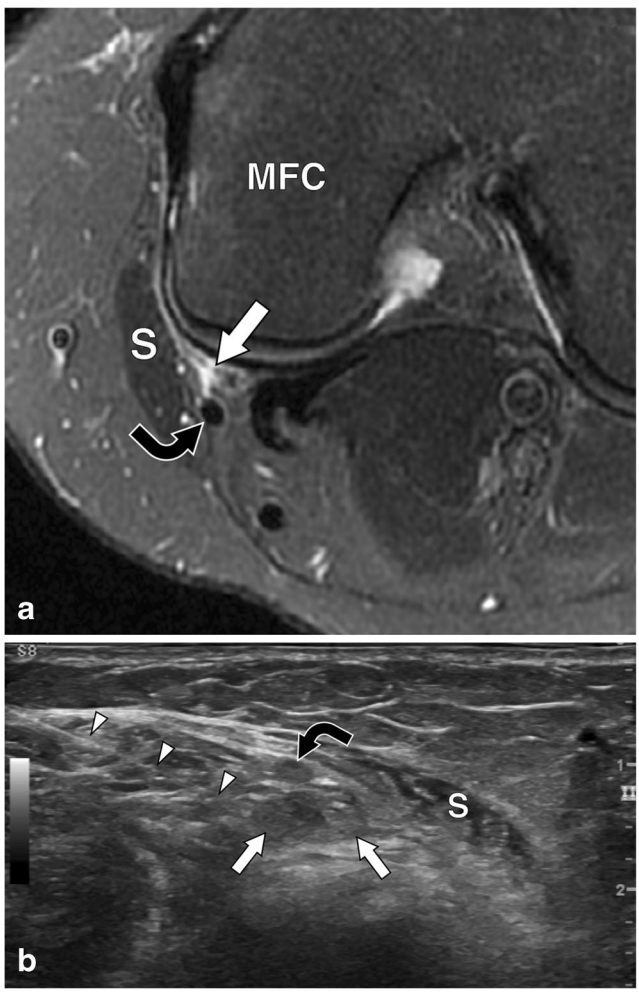

Fig. 3 **a** A 52-year-old woman with posteromedial knee pain. Axial T2FS MRI of the left knee demonstrates moderate edema (*arrow*) between the MFC and sartorius (*S*) and gracilis (*curved arrow*). **b** Ultrasound image in the transverse plane shows 25G needle (*arrowheads*) with the tip deep to the sartorius (*S*) and gracilis (*curved arrow*) with the initial bolus of medication (*arrows*)

asked to reproduce motions known to provoke symptoms and their intensity was scored using the VAS. The patient was discharged with instructions for self-assessment. Post-injection follow-up was performed per clinical protocol by phone or e-mail after 2 and 8 weeks. On follow-up, subjects provided:

1. Information about potential complications
2. A binary (yes/no) self-assessment regarding symptom improvement
3. Subjects with improvement rated pain levels before and after steroid/anesthetic injection using the VAS

Statistical analyses

Statistical analyses were conducted using a pairwise *t* test for within-group comparisons of VAS scores. All values are expressed as mean ± standard deviation. All statistics were calculated using JMP Pro software (version 11; SAS Institute, Cary, NC, USA). $p < 0.05$ was considered significant.

Results

A total of 14 subjects were evaluated for suspected posteromedial knee friction syndrome. Subjects had clinical presentation that included varied degrees and combinations of medial knee pain. The mean age was 38 ± 11 years and the majority of subjects were female (13/14, 93%). The left knee was more frequently affected (10/14, 71%). Indications for MRI showed that medial meniscal tear was suspected in 10/14 (71%) of patients. The mean time period between a patient's visit to the referring clinic and obtaining MRI was 7 ± 11 weeks. The time between MRI diagnosis and ultrasound-guided injection was 3 ± 2 weeks. Ultrasound examination revealed abnormal tendon motion in relation to the MFC in 2 out of 14 (14%; Video 2), with abrupt motion of the tendon over MFC at extension. The remaining patients did not reveal abnormal motion. The mean pre-procedural VAS was 5.2 ± 2.7 and a medial McMurray sign was present in 10 out of 14 (71%) patients. Additional data regarding demographics and symptom characteristics are given in Table 1.

Technical success for the injection was achieved in all cases. There were no cases of infection, abnormal bleeding, hematoma, or allergic reactions. Follow-up information was available immediately after the procedure for all subjects ($n = 14$), and at 2 and 8 weeks in 13 subjects. Immediately after the injection, symptoms decreased to 2.2 ± 2.4 on the VAS ($p = 0.0008$, compared with pre-procedural VAS). At 2 weeks, mean VAS score was 2.2 ± 2.3 ($p = 0.0002$, compared to pre-procedural VAS) and at 8 weeks, 0.9 ± 2.1 ($p = 0.0002$, compared with pre-procedural VAS). No subjects underwent surgery of the involved knee for the duration of follow-up. Of the 10 subjects with pre-procedural positive medial McMurray sign, 7 turned negative and 3 had decreased symptoms immediately after the procedure. Overall, symptom improvement at 8 weeks occurred in 12 out of 13 (92%) of patients.

The mean distance between sartorius and gracilis to MFC was 2.8 ± 0.7 mm and 5.0 ± 2.3 mm, respectively. The degree of edema was mild in 4 out of 14 (28.5%), moderate in 6 out of 14 (43%), and severe in 4 out of 14 (28.5%) subjects. MRI

Table 1 Pre-procedural characteristics of study cohort

ID	Age	Sex	Side	Original MRI clinical indication	Inciting activities	Posteromedial pain at flexion/extension	McMurray sign (medial)	Ultrasound findings	MR edema
1	52	Female	Left	Medial meniscal tear	None	–	–	None	Moderate
2	47	Female	Left	Medial meniscal tear	None	+	+	None	Severe
3	44	Female	Left	Medial meniscal tear	Running	–	+	Tendon vs MFC	Moderate
4	51	Female	Left	Medial meniscal tear	None	+	+	None	Mild
5	28	Female	Left	Medial meniscal tear	Walking	+	+	None	Moderate
6	47	Female	Right	Medial meniscal tear	None	–	+	None	Moderate
7	30	Female	Right	Medial meniscal tear	Fall	+	+	None	Mild
8	29	Male	Right	Evaluate for friction syndrome	None	+	+	Tendon vs MFC	Moderate
9	28	Female	Left	Internal derangement	None	+	–	None	Mild
10	41	Female	Right	Medial meniscal tear	Zumba workout	+	–	None	Severe
11	21	Female	Left	Lachman/pivot shift test positive	None	–	–	None	Moderate
12	46	Female	Left	Chronic pain	None	+	+	None	Severe
13	21	Female	Left	Medial meniscal tear	Horseback riding	+	+	None	Severe
14	42	Female	Left	Medial meniscal tear	Running	+	+	None	Mild

+ present/positive; − absent/negative, *MFC* medial femoral condyle

findings consistent with concurrent friction syndromes were noted in 7 out of 14 (50%) patients: iliotibial friction syndrome in 1 out of 14 (7%) and patellar tendon/lateral femoral condyle friction syndrome in 6 out of 14 (43%).

Discussion

Posteromedial knee friction syndrome is a novel entity that postulates abnormal motion between the sartorius and/or gracilis relative to MFC resulting in irritation of entrapped soft tissues [9]. It is more common in young adult females, presenting with medial joint line pain and initially raises suspicion for medial meniscal tear [9]. On MRI, narrower spaces between the sartorius/gracilis and MFC were noted when compared to matched controls—given the absence of other abnormalities and localized pain with soft tissue edema, a friction syndrome was postulated [9]. As is the case with other knee friction syndromes, symptoms of posteromedial knee friction syndrome can be confused with meniscal or chondral lesions [1–4]. Notably, 27% of subjects with posteromedial knee friction syndrome showed MRI evidence for another knee friction syndrome, mostly between the patellar tendon and lateral femoral condyle [9]. In our study, 71% of patients were referred to MRI for a suspected medial meniscal pathological condition, and 50% presented concurrent knee friction syndromes.

Owing to the extra-articular location of the abnormality in posteromedial knee friction syndrome, a targeted injection with anesthetic and/or corticosteroid may support the diagnosis and help to rule out intra-articular pain generators, such as meniscal tears and cartilage defects. Further, it may provide mid- to long-term symptomatic relief. In the original description of this entity, the authors described 2 subjects in whom an ultrasound-guided injection of lidocaine and triamcinolone provided substantial pain relief immediately following the procedure [9]. However, a detailed description of the injection technique and long-term follow-up were not available. Our study builds upon that evidence and examines the effect of such a treatment strategy in a larger cohort of patients with follow-up information available up to 8 weeks after the procedure.

The results of our study show that anesthetic and corticosteroid injection at the site of posteromedial edema provided sustained symptom relief and functional recovery in most patients. Furthermore, when performed under ultrasound guidance, these procedures are safe and have a high degree of technical success. In our cohort of ultrasound-guided procedures, a statistically significant 83% VAS decrease was noted at 8 weeks' follow-up, with no complications.

Our patients with suspected posteromedial knee friction syndrome presented distances between the sartorius/gracilis and femoral condyle that were higher than previously reported narrowed spaces in affected subjects [9]. This finding may reflect the variability in knee flexion during MRI and raises the possibility that static measures on MRI may not fully capture the potential cause of this syndrome. Further, in our study, dynamic ultrasound performed before injection revealed abnormal tendon motion at the posteromedial knee in only 2 subjects, in which the gracilis showed abrupt motion over the MFC at extension. The lack of obvious abnormal tendon motion in most cases raises the possibility that passive flexion and extension—in a prone nonweightbearing position—may not consistently demonstrate the mechanism for posteromedial knee friction. Further studies using dynamic ultrasound during weightbearing or while actively performing pain-inciting motions should help to clarify the biomechanical source of this entity. We speculate that the etiology might be multi-factorial, with a combination of tendon proximity to the bone, abnormal tendon motion, and possibly an abnormal gait pattern, leading to repetitive tendon–bone friction when the knee is extended and externally rotated. This is further supported by our observation of a high prevalence of a positive medial McMurray sign, which resolved in a high percentage of patients immediately after the injection. It is possible that this provocative maneuver accentuates contact between posteromedial tendons and MFC, eliciting pain that overlaps with meniscal tear symptoms.

Our study has limitations because of its retrospective nature. Patients who were triaged for the procedure already had a high degree of suspicion for the entity. In this regard, it is possible that subjects with posteromedial knee pain but no edema on MRI were not referred for this particular procedure. In addition, patients with other sources of medial knee pain were likely redirected to different management options. Our series did not include patients with obvious anatomical derangements causing abrupt tendon motion. In snapping syndromes affecting the medial knee, previous studies have described conservative and surgical treatments, the latter including semitendinosus tendon harvest and release of the semitendinosus and gracilis tendons [10]. Instances in which abnormal medial tendon motion was caused by osseous prominences [11] or a meniscal cyst [12] were treated using surgical excisions of these abnormalities. Importantly, although our procedure provided significant relief in subjects with focal edema, the response alone may not fully explain the pathomechanics of this entity. Although posteromedial knee friction syndrome has similarities with other medial knee snapping syndromes, the success of our minimally invasive treatment suggests that it might play a role in initial management, combined with conservative strategies that may include physical therapy and neuromuscular re-education. However, no specific treatment regimens have been specifically developed for this entity. Finally, although we describe responses to our procedure at 8 weeks' follow-up, symptoms beyond this timeframe were not available, and could provide further insight into the extended efficacy of this treatment option.

Posteromedial knee friction syndrome is a painful condition that responds to ultrasound-guided treatment with

corticosteroid and anesthetic. Ultrasound guidance provides optimal visualization of local structures, allowing safe and precise delivery of medication. Our study may support further investigations and guide management in patients with medial knee pain and MRI findings of edema between the sartorius/gracilis and the MFC.

Compliance with ethical standards

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

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed consent Informed consent was waived for individual participants included in the study. The study was approved by the local Institutional Review Board (IRB) and HIPAA-compliant.

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