Technical Note

Proximal Rectus Femoris Avulsion Repair

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Abstract: Proximal rectus femoris tendon avulsions are rare and occur mostly in male athletes. Currently, the standard of care for complete tendinous avulsions of the direct arm of the rectus femoris is nonoperative treatment. However, surgical repair may be considered in high-level athletes who have a high demand for repetitive hip flexion performed in an explosive manner or in patients in whom nonoperative treatment has failed. The purpose of this technical note is to describe the method for surgical repair of the proximal direct arm of the rectus femoris to its origin at the anterior inferior iliac spine using suture anchors.

Proximal rectus femoris tendon avulsions are rare and account for approximately 1.5% of hip lesions that occur during sports.[1] This lesion is more frequent in athletes practicing sports that involve sprinting and kicking,[2] such as track and field, football, rugby, and soccer. The cause of these tendinous tears is still unknown, and a wide range of risk factors have been suggested within the literature.[1] The rectus femoris is the only biarticular muscle of the quadriceps muscle group and contains a high percentage of rapid-contraction muscular fibers.[3] In addition, it is the most frequently torn muscle within this group.

Proximal rectus femoris lesions most commonly occur during hip hyperextension and knee flexion or as a result of a sharp eccentric contraction of the quadriceps.[4] Although standard treatment is nonoperative management, good results have been reported with surgical treatment in a select group of patients, particularly high-level athletes.[2,3,5-8] The purpose of this technical note is to describe the method for surgical repair of the proximal direct arm of the rectus femoris to its origin at the anterior inferior iliac spine (AIIS).

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Diagnosis

Clinically, acute cases often present with pain located inferior to the AIIS, tenderness, and ecchymosis. Pain, discomfort, and weakness are commonly reported when the knee is extended against resistance. In chronic cases, patients may report weakness with knee extension and hip flexion and tenderness over the anterior hip. Magnetic resonance imaging is the preferred method to confirm a proximal rectus femoris avulsion. Preoperative evaluation with magnetic resonance imaging is recommended to evaluate the degree of tear extension and muscular retraction (Figs 1 and 2).

Indications

Most rectus femoris tears are treated nonoperatively. However, surgical repair may be considered in high-level athletes who have a high demand for repetitive hip flexion performed in an explosive manner such as kickers and sprinters. This procedure is not indicated for nondisplaced or minimally displaced avulsions, musculotendinous tears with minimal or no muscular retraction, and chronic tears in low-demand elderly patients without pain who have an acceptable functional level because of excellent results with conservative management.[4,9,10] It is the opinion of the senior author (C.P-G.) that patients in whom nonoperative treatments fail (continued pain or weakness) for more than 3 months may also be considered for surgical treatment. Indications and contraindications are summarized in Table 1.

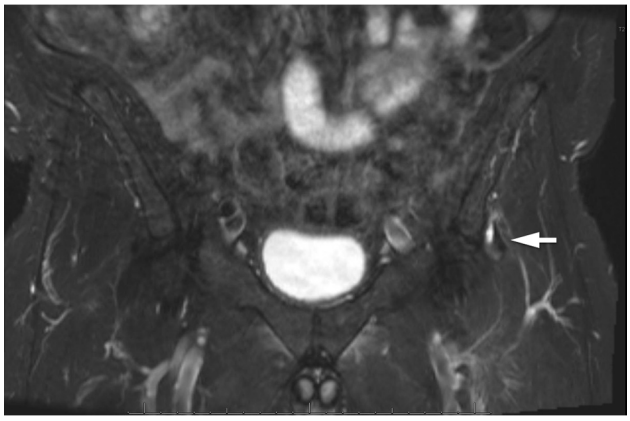

Fig 1. Coronal T2-weighted magnetic resonance image showing an avulsion of the left direct head of the rectus femoris (arrow) from the anterior inferior iliac spine. The contralateral (right) direct head of the rectus femoris is intact and remains attached to the anterior inferior iliac spine.

Surgical Technique

Patient Positioning

The patient is positioned supine on the operating table, and general anesthesia is used for induction. The contralateral leg is placed in full extension with sequential compression devices to prevent deep vein thrombosis. Draping should be performed proximal to the anterior superior iliac spine (ASIS) and distal to the knee. The affected-leg preparation should allow for free range of motion to facilitate the tendon repair.

Surgical Steps

Step 1: Skin Incision. First, landmarks are identified and marked, including the greater trochanter and the ASIS. A 6-cm longitudinal incision is created starting slightly distal and lateral to the ASIS and extended distally following the Smith-Petersen approach (Video 1, Fig 3).

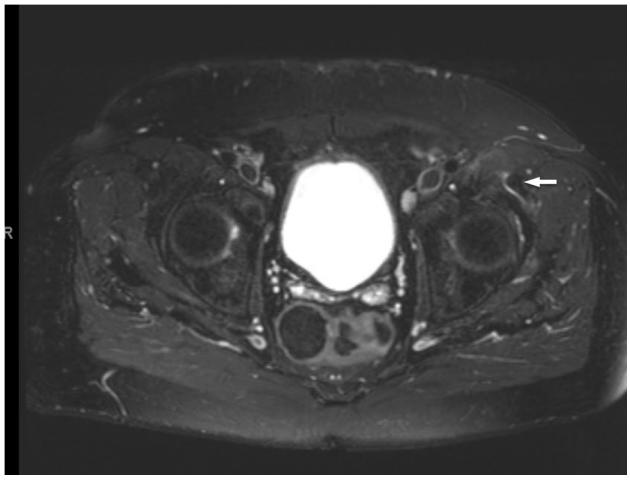

Fig 2. Axial magnetic resonance imaging cut showing the left rectus femoris tendon (direct head) avulsed from the anterior inferior iliac spine (arrow).

Table 1. Indications and Contraindications

Indications
High-level athletes with significant demand for repetitive explosive hip flexion
Failure of nonoperative treatment with continued pain or weakness for >3 mo
Contraindications
Nondisplaced or minimally displaced avulsions
Musculotendinous tears with minimal or no muscular retraction
Chronic tears in low-demand patients with acceptable function and minimal or no pain

Step 2: Approach. Next, the Smith-Petersen approach is performed through the interval between the tensor fascia lata (TFL) and the sartorius. The fascia is opened cautiously and dissected carefully to avoid iatrogenic damage to the lateral femoral cutaneous nerve (LFCN) that runs medially to the ASIS beneath the inguinal ligament. Of note, the anatomy of this nerve is highly variable, and this should be kept in mind when performing this step. Most commonly, the LFCN crosses the interval between the TFL and sartorius 2 to 4 cm distal to the ASIS. The TFL is retracted laterally, and the sartorius and LFCN are gently retracted medially. The deep fascia between the sartorius and the TFL is identified and incised. The rectus femoris should be identified at this point in the deep layer (Fig 4).

Step 3: Identification of Tear and Mobilization of Rectus. The rectus femoris is identified, and the degree of retraction is assessed. Once identified, the

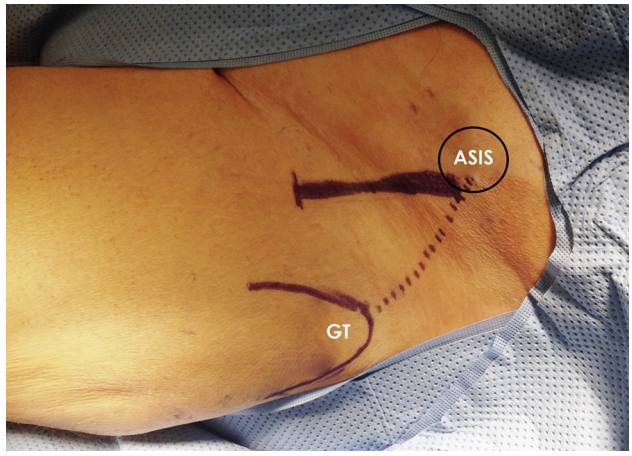

Fig 3. Pertinent landmarks for the Smith-Petersen approach shown on a left hip. The thick solid line represents the planned incision, and the thinner solid line represents a rough outline of the greater trochanter (GT). The dotted line represents the relationship between the GT and the anterior superior iliac spine (ASIS).

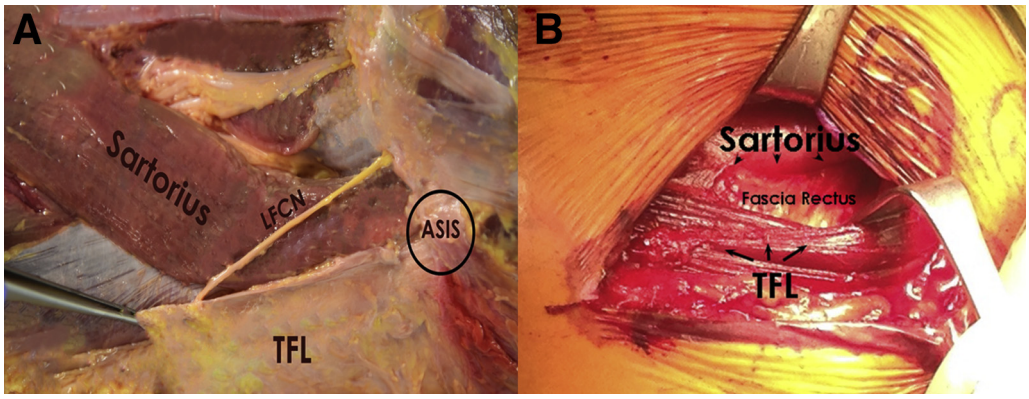

Fig 4. (A) Cadaveric dissection showing the lateral femoral cutaneous nerve (LFCN) crossing over the sartorius 2 to 4 cm distal to the anterior superior iliac spine (ASIS). (B) The Smith-Petersen approach is performed through the interval between the tensor fascia lata (TFL) and the sartorius. The fascia of the rectus can be observed deep to the TFL and sartorius.

tendon and adhesions are released from the surrounding tissues. It is important at this point to assess both proximal origins of the rectus femoris (direct and indirect heads) (Fig 5). Often, only the direct arm is affected at its insertion into the AIIS because the indirect arm has a broader area of insertion. In cases in which both arms (indirect and direct) are affected, repair will be performed on each arm separately, in accordance with normal anatomic insertion.

Step 4: Preparation of Tendon and AIIS. All of the devitalized and degenerated tendon should be removed from the tendon stump. A suture is passed through the direct arm to help with mobilization. The footprint of the direct arm of the rectus (AIIS) is then prepared by removing the soft tissues to expose subchondral bone and improve visibility, which will help with anchor placement. A rasp is used to create a bleeding bony bed on the footprint where the repair will be performed to support healing (Fig 6).

Step 5: Placement of Suture Anchors and Reattachment of Tendon to AIIS. The suture anchors are placed over the primitive footprint, and the tendon is reattached to its native origin. Because of the small footprint of the rectus femoris, it is only possible to place 1 or 2 anchors at most. It is recommended to reattach the tendon in a double-row fashion. First, an all-suture anchor (Iconix 2; Stryker, Mahwah, NJ) is used to establish the medial row. The strands of suture from the anchor are passed through the tendon from deep to superficial. The previously placed mobilization suture is then removed. The surgeon applies tension to the tendon while holding the sutures from the suture anchor so that the tissue is reduced and compressed against the bone. The sutures are then tied over the tendon. After that, a hole is drilled for the second anchor, proximal to the first one. Both strands are passed through the second anchor (SwiveLock; Arthrex, Naples, FL), and the tissue tension is evaluated. Once the surgeon is satisfied with the location of the second anchor, it is

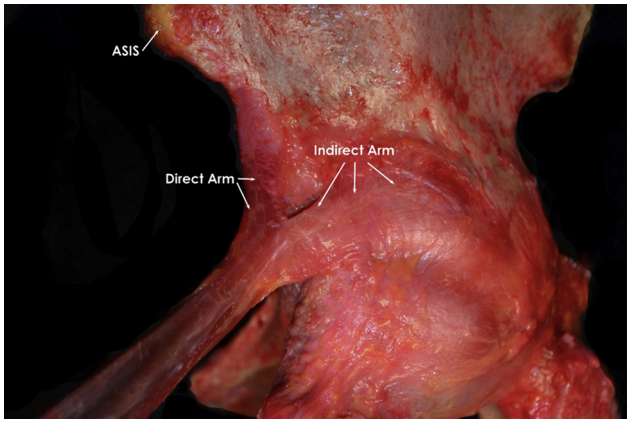

Fig 5. Cadaveric image of the proximal insertion of the rectus femoris. One should note how the direct arm attaches to the anterior inferior iliac spine (AIIS) and how the indirect arm has a broader insertion that attaches to the superior acetabular ridge.

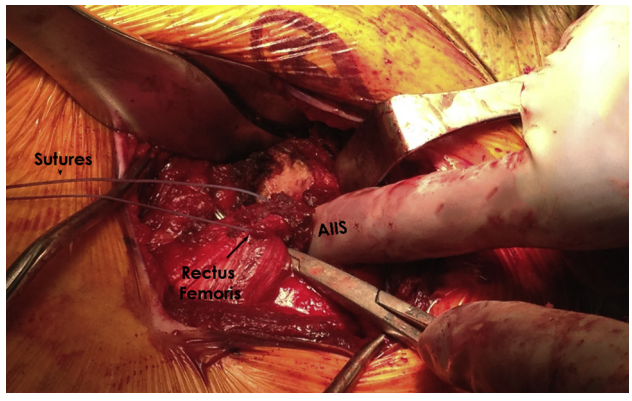

Fig 6. The direct arm of the proximal rectus femoris tendon is shown with mobilization sutures placed through it, and the surgeon's finger is pointing at the anterior inferior iliac spine (AIIS).

introduced into the bone socket and adequate tension is obtained. If necessary to help reattach the proximal tendon, the hip can be flexed to decrease the tension of the rectus tendon while it is being reattached to its native location. The tendon should completely cover the anterior and inferior surfaces of the AIIS, without excessive tension.

Postoperative Rehabilitation Protocol

After surgery, the patient is placed in a knee brace (DJO, Vista, CA) locked in extension for 6 weeks to prevent active contraction of the rectus femoris. A continuous passive motion machine is also used for 6 to 8 hours a day (0° to 90°) to prevent postoperative arthrofibrosis and stiffness of the knee and hip. During this period, the patient is restricted to non–weight bearing. In addition, the patient is instructed to avoid active flexion of the hip. Physical therapy starts in the fourth postoperative week, focusing on range of motion. After the first 6 weeks, partial progressive weight bearing with crutches is initiated. At this time, the patient is weaned from crutches, and their use is discontinued when the patient can walk without a limp and with minimal pain. Eccentric strength-training exercises and running typically begin after 8 weeks. Return to play normally occurs between 4 and 6 months after surgery.

Discussion

Avulsions of the direct head of the rectus femoris are unusual.[1] No controlled trials have been conducted on the treatment of direct head avulsions or, to our knowledge, on the treatment of proximal rectus ruptures in general. The most frequent treatment is nonoperative, with surgery reserved only for high-activity patients such as elite athletes or patients in whom nonoperative treatment has failed.[3,5] Reattachment with suture anchors is the gold standard for operative fixation.[2,6,7] We propose a double-row suture, as in rotator cuff repair, with 2 anchors to give more strength to the suture and prevent potential failures with early rehabilitation.

Both operative and nonoperative treatments have shown good clinical results. The largest reported case series included 11 cases, in which conservative treatment was performed in professional football players.[10] Patients were back to playing after 6 to 12 weeks after injury. The largest case series of surgical treatment of proximal rectus femoris injuries were performed by García et al.[2] and Irmola et al.[6] García et al. reported 10 cases of injury to the direct arm of the rectus femoris in professional soccer players who were treated surgically. Nine of the cases underwent augmentation with plasma rich in growth factors at the end of the procedure. No complications were reported, and return to professional competition occurred at 3.8 months (±0.8 months). Irmola et al. reported 5 cases of complete proximal avulsions of the direct arm of the rectus repaired with suture anchors. Four of the patients were professional soccer players, and 1 was a national-level hurdler. All of the patients were able to return to their preinjury level of activity 5 to 10 months after surgery. Two patients reported temporary loss of sensation and tenderness over the lateral thigh due to damage to the LFCN. Gamradt[10] evaluated results of nonoperative treatments, reporting a recurrence of symptoms in 2 of 11 patients with conservative treatment. On the contrary, all 15 patients who underwent surgical treatment in the studies by García et al. and Irmola et al. reported a full recovery without recurrence of symptoms. Hsu et al.[4] reported 2 cases of high-level athletes treated nonoperatively with good clinical outcomes and return to play after 3 months.

Limited evidence exists on whether to perform single- or double-row reconstruction in rectus femoris repairs. However, the body of literature regarding rotator cuff repairs is significantly broader, and therefore, we can infer that similar results for this technique may be possible, such as a potentially higher rate of tendon healing,[11] in addition to the possibility of performing accelerated postoperative rehabilitation in a safer manner with a double-row technique[12] because of the added strength[13,14] and a decreased incidence of retears.[13] However, this has yet to be validated in rectus femoris repairs. Moreover, we acknowledge that the surgical time can be increased because the procedure is more technically demanding and the cost is elevated because more anchors are used. Pearls and pitfalls of this procedure are summarized in Table 2.

In conclusion, there is no consensus regarding the optimal treatment for ruptures of the rectus femoris muscle. Both operative and nonoperative treatments have shown good clinical outcomes; however,

Table 2. Pearls and Pitfalls

Pearls
The surgeon should clear the tendinous footprint on the AIIS of soft tissues and use a rasp to create bleeding healthy bone to stimulate healing.
Flexing the knee while reattaching the direct arm will decrease tension.
The tendon should completely cover the anterior and inferior surfaces of the AIIS.
The double-row technique provides more strength to the repair and may prevent possible failures with early rehabilitation.
Pitfalls
There is a risk of LFCN injury because of common anatomic variability of this nerve.
Failure to use a continuous passive motion machine can lead to postoperative arthrofibrosis and stiffness of the knee.
If the retracted tendon is not released of surrounding adhesions, adequate mobilization will be difficult to achieve.

AIIS, anterior inferior iliac spine; LFCN, lateral femoral cutaneous nerve.

nonoperative treatment may predispose to recurrence of symptoms, especially in high-level athletes. We believe surgical treatment with reattachment of the tendon to its origin with suture anchors should be indicated only in high-level athletes or in patients in whom nonoperative treatment has failed, and we encourage other surgeons to use our technique and report on their outcomes.

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