Technical Note

Endoscopic Proximal Hamstring Tendon Repair for Nonretracted Tears: An Anatomic Approach and Repair Technique

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Abstract: Proximal hamstring injuries are common, and open surgical repair with suture anchors has been the gold standard when surgical intervention is warranted. Endoscopic techniques offer the opportunity of surgical repair with smaller incisions to limit complications and expedite rehabilitation. The purpose of this technique guide is to describe a modified endoscopic technique that allows a safe and anatomic repair of proximal hamstring injuries. The patient is positioned prone with the feet at the head of the bed, table in reverse Trendelenburg, and knees flexed to 90°. Four portals are used, 3 in horizontal alignment within the gluteal fold and 1 directly superior to the ischial tuberosity. The sciatic nerve is identified, dissected, and mobilized away from the operative field. Retraction sutures help retract the gluteus maximus and further protect the sciatic nerve. Dissection is within the interval between the conjoint and semimembranosus tendons. The tendons are freed and mobilized, the ischial tuberosity is decorticated, and an anatomic repair is performed via 4 suture anchors, 2 at each tendon footprint. Advancements in arthroscopy have permitted adequate visualization and exposure of the hamstring footprint, thus allowing for an anatomic repair with increased protection of the sciatic nerve and decreased resources and cost.

Proximal hamstring injuries are increasingly common. The vast majority occur in 2 forms: traumatic, complete retracted tears; and chronic, nonretracted partial- to near-full-thickness tears. Open surgical repair with suture anchors has been the gold standard when surgical intervention is indicated. However, access to the ischium, particularly when the entire repair is done at the ischium, can be significantly restricted. With the advent of improved technology and endoscopic techniques, endoscopic hamstring repair has recently been pioneered.[1-5] During open repair, complications related to extensive tissue exposure and the proximity of the incision to the perianal zone have been described. Endoscopic techniques offer the opportunity to better visualize neurovascular structures with smaller incisions to limit complications and expedite rehabilitation. They also offer better access to achieve a more anatomic repair. The proximal hamstring consists of 2 distinct tendons, the conjoint and semimebranosus. The natural interval between the 2 offers an ideal entry point to repair the tendons. Here, we present a modified endoscopic technique for a safe and anatomic repair of nonproximal or minimally proximal hamstring injuries.

Anatomy

The hamstring muscle complex comprises 3 muscles: the semimembranosus, semitendinosus, and biceps femoris. The semitendinosus and long head of the biceps femoris form the conjoint tendon with a crescent-shape footprint originating at the superomedial ischial tuberosity. The semimembranosus originates from the superolateral ischial tuberosity, lateral and anterior to the conjoint tendon. There is a distinct fatty interval

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between the semimembranosus and the conjoint tendon no more than 2 cm distal to the tuberosity. The hamstring muscles insert distally below the knee on the proximal tibia, are innervated by the tibial branch of the sciatic nerve, and receive their arterial supply from the perforating branches of profunda femoris artery, inferior gluteal artery, and the superior muscular branches of the popliteal artery. The hamstrings are a unique muscle group in that they cross and act on 2 joints, both the hip and knee. Together, the hamstring muscles extend the thigh, flex the knee, and rotate the tibia medially (internal rotation).

Injury Mechanism, Presentation, and Workup

Hamstring injuries can occur at any level in the muscle complex: proximally at the origin on the ischial tuberosity or more distally at the myotendinous junction. Proximal hamstring tears can be categorized as complete tendinous avulsions, partial tendinous avulsions, apophyseal avulsions, or degenerative avulsions (tendinosis). The study by Koulouris and Connell[6] showed that only 12% of hamstring muscle injuries were proximal ruptures, and 9% were complete. This technique is primarily focused on partial avulsions (traumatic or degenerative). The presentation of these injuries may be more vague and difficult to diagnose. Sitting pain is common, but functional pain (stairs, hiking, sprinting) is a more specific finding for hamstring pathology rather than other causes of buttock pain. Patients with a suspected hamstring injury should undergo a radiographic workup with, at minimum, an anterior-posterior view of the pelvis to evaluate for an avulsion off of the ischial tuberosity. Magnetic resonance imaging (MRI) is the gold standard to evaluate for hamstring injury; however, it should be reserved for patients in whom a complete rupture is suspected or who do not respond to conservative management.

Treatment Options

The management of hamstring injuries is directed by severity of injury and concomitant patient factors. Nonoperative management of hamstring injuries is most commonly recommended in the setting of low-grade, partial tears and insertional tendinosis. In addition, conservative management is indicated for single tendon injuries with retraction of <1-2 cm or rupture at the myotendinous juncture.[7] This encompasses the majority of hamstring injuries. Initial treatment consists of rest, ice, activity modification, oral nonsteroidal anti-inflammatory medications, and a physical therapy program consisting of protected weightbearing for 4 weeks followed by stretching and strengthening.[8] If the patient fails to improve with conservative management, an ultrasound-guided corticosteroid injection has been shown to provide initial relief in ≤50% of patients at 1 month.[9]

Suggested surgical indications include complete, proximal avulsion ruptures, partial avulsion injuries that have failed nonoperative management with persistent symptoms after 6 months, or at least 2 tendons injured with >2 cm retraction in young, active patients (Table 1).[7] Open surgical repair for complete proximal ruptures results in significantly better subjective outcomes, greater rate of return to preinjury level of sport, and greater strength/endurance compared with nonsurgical management.[8,10] However, open surgical repair results in a complication rate of 23.17% and a return to sport of 79.75%.[8] Thus, although open surgical repair of acute proximal hamstring injuries has significantly improved the functional prognosis of patients, there remains an opportunity to improve outcomes.

Although open repair remains the gold standard when surgical intervention is warranted, complications related to extensive tissue exposure and the proximity of the incision to the perianal zone have led to the description of endoscopic techniques. In addition, access to the ischium can be limited and restricted, making an anatomic repair challenging. Endoscopic repair of proximal hamstring avulsion injuries was first described by Dierckman et al.[2] in 2012 with a few additional modified techniques outlined[1,3-5] and only 1 report of outcomes, in German.[11] Similar to the inherent challenges of any new arthroscopy technique, there is a steep learning curve, with sufficient repetition required for mastery. Here, we build on the techniques developed by pioneers in this area and present a modified endoscopic technique with the goal to instruct how to perform a safe and anatomic repair of proximal hamstring injuries.

In this technique guide, we present a recommended technique for arthroscopically repairing proximal hamstring injuries. In particular, we focus on an anatomic approach to partial-thickness tears, but the senior author uses the endoscopic technique more

Table 1. Operative indications

General Indications[7]	Author's Endoscopic Indications
2 hamstrings are retracted >2 cm from ischial tuberosity	High-demand patient with an acute or chronic full-thickness tear with ∼2-5-cm retraction of the tendon
3 hamstrings are avulsed from ischial tuberosity	Chronic tendinopathy with a partial- or full-thickness tear after failure of conservative management
Failure to improve after >6-month trial of nonoperative management	

broadly. The senior author's indications for endoscopic repair are (1) chronic tendinopathy and a partial- or full-thickness tear after failure of conservative management and (2) an acute or chronic full-thickness tear with ∼2-5 cm of tendon retraction in high-demand patients. Essentially, if the tendon is under the gluteus maximus, we prefer the endoscopic approach.

Technique

Equipment

- 30° scope;
- 4-5 double- or triple-loaded suture anchors (all suture preferred, Iconix Speed triple-loaded suture tape; Stryker, Kalamazoo, MI);
- Suture-passing device (Slingshot, Stryker);
- 4.0- or 5.5-mm round burr (Stryker);
- Microfracture drill system (Phoenix, Stryker); and
- Radiofrequency probe (Multivac 50, Smith & Nephew, London, UK).

Positioning and Draping

The following is a detailed technique of the procedure shown in Video 1. The patient is placed prone on a standard operating room table. The bed is physically rotated 180° so that the foot is at the head. Padding is placed on all bony prominences, and neurovascular structures are protected. The patient's hip and knee are aligned with folds in the bed. The bed is then flexed at both points to flex the torso and the knees. The knees are bent close to 90° to decrease tension on the sciatic nerve and hamstring. The bed is then placed in reverse Trendelenburg to level the spine in relation to the floor (Figure 1). Appropriate positioning is critical, as it facilitates access to the hamstring and increases the working space of the portals while decreasing risk of neurovascular injury. The operative foot is left out of the sterile field and free to later detect any movement. A paddle is placed on the lateral side of the operative leg at about midcalf level to protect the leg. The contralateral leg is secured with a safety strap. The gluteal cleft is protected with Ioban dressing as an additional step to prevent contamination from the perineal region. The sterile field is draped out from the lumbar spine to the distal thigh ∼2-3 cm above the knee.

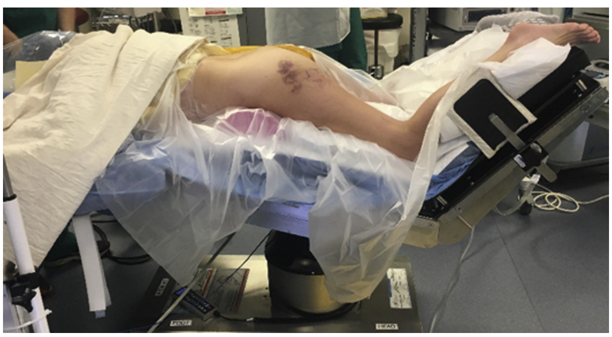

Figure 1. Clinical photograph showing patient positioning. The patient is positioned prone on a standard operating room table. The bed is then flexed at both points to flex the torso and the knees. The knees are bent close to 90° to decrease tension on the sciatic nerve and hamstring. The bed is then placed in reverse Trendelenburg to level the spine in relation to the floor. The operative foot is left out of the sterile field and free. A paddle is placed on the lateral side of the operative leg at about midcalf level to protect the leg. The contralateral leg is secured with a safety strap. The gluteal cleft is protected with Ioban dressing, and the sterile field is draped out from the lumbar spine to the distal thigh ∼2-3 cm above the knee.

The gluteal region is then prepped and draped in standard sterile fashion. Landmarks are identified and marked with an indelible marker. The ischial tuberosity is palpated and marked, as well as the gluteal crease and the suspected path of the sciatic nerve, ∼1.2 cm lateral to the ischial tuberosity.

Accessory Distal Portal and Accessory Proximal Portal Placement

The accessory distal (AD) portal is established first. In the gluteal fold, a spinal needle is used to confirm localization of the ischial tuberosity. The lateral border of the ischial tuberosity is identified by tactile sensation. Once confirmed, a 1-cm horizontal incision is made in line with the gluteal fold. The trochar for the scope is placed through the incision and again used to palpate the ischial tuberosity. Once confirmed, the scope is introduced, and fluid pressure is started at 25 mmHg to decrease the risk of overpressurizing and causing excessive extravasation and nerve injury. The tuberosity is then arthroscopically visualized.

Under direct visualization, the accessory proximal (AP) portal is established with a spinal needle using an outside-in technique. The portal is placed ∼5-10 cm superior to the AD portal. A horizontal incision is made, and a switching stick is inserted and localized through the scope. A second scope trochar is then placed over the switching stick so that it can be directly visualized without the need to remove the initial trochar. Once the second trochar has been established, the scope is removed from the AD portal and placed into the AP portal. The switching stick is then placed into the AD portal.

It is critical that the AP and AD portals are parallel to one another and in the interval between the proximal hamstring tendon and sciatic nerve. This allows for initial dissection and development of the working space in line with the sciatic nerve. See Figure 2 for a clinical representation of landmarks and portal placement.

Exposure: Nerve Identification and Dissection

The sciatic nerve and hamstring tendons are identified. The ischium is used as a tactile safe landmark to

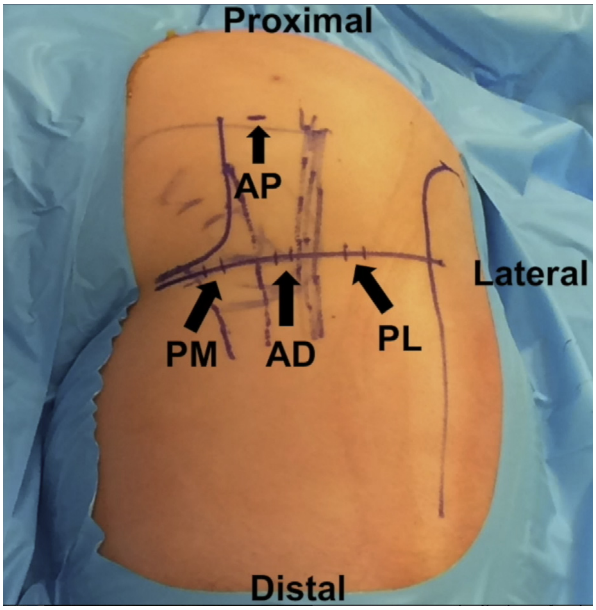

Figure 2. Clinical photograph showing landmarks and portal placement. The ischial tuberosity and gluteal fold are palpated and drawn, as well as the anticipated corresponding locations of the hamstring tendon and sciatic nerve. Four portals are used, 3 in horizontal alignment within the gluteal fold and 1 directly superior to the ischial tuberosity. The accessory distal (AD) portal is established first as the primary working portal and the accessory proximal (AP) portal second as the primary viewing portal. The posteromedial (PM) and posterolateral (PL) portals are created in horizontal alignment with the AD portal at the level of the gluteal crease.

start from. At this point, an unsterile assistant is positioned at the foot of the bed and places a hand on the ipsilateral foot to monitor for any nerve activation. The switching stick in the AD portal is used for gentle blunt dissection of the space, in line with the structures. At times, radiofrequency ablation may be needed to clear fatty tissue. Use of the shaver is limited, to decrease the risk for iatrogenic nerve injury. Fascial bands and thickened bursa are common, and patience and gentle dissection is critical for protection of the sciatic nerve. The most difficult area to mobilize the nerve is proximal and anterior. However, it is necessary to mobilize the nerve here to allow access to the semimembranosus tendon.

Blunt dissection is taken laterally from the ischial tuberosity with the switching stick for sciatic nerve identification. Throughout the dissection, an assistant's hand remains on the ipsilateral foot and closely observes for possible muscle activation from nerve irritation. The nerve may be gently stimulated upon identification to confirm a response. The sciatic nerve is lateral and anterior (deep in incision) to the ischial tuberosity. The posterior cutaneous branch of the sciatic nerve will also be encountered and should be protected. Once the sciatic nerve is identified and dissected with good mobilization, the nerve is mobilized to allow access for a safe tendon repair.

The hamstring tendons are then identified medial to the sciatic nerve. The hamstring origin on the ischium is probed to assess the tendon underneath. Although the hamstring tendons are often retracted, they retain their structure. The semitendinosus and biceps femoris attach medially on the ischial tuberosity and form the conjoint tendon. The semimembranosus inserts more laterally and anteriorly (deep in incision) than the conjoint tendon. If retracted, the plane between the conjoint tendon and the semimembranosus can serve as a useful anatomic landmark. The tear is accessed through the conjoint tendon and semimembranosus interval to facilitate repair of the entire footprint.

At this juncture, the extent of the tear is evaluated. All partial-thickness tears will have a normal superficial appearance, but the tendon is clearly excessively mobile when probed, indicating detachment underneath. The deep aspect of the tendon and ischium is then approached—this is the key unique aspect of our technique. We approach the ischium through the interval between the conjoint and semimembranosus tendons. The interval is released both distally and proximally until the footprint is easily accessible for repair. This may require detachment of any remaining tendon from the footprint in the setting of a partial tear. Remaining in this interval ensures that the nerve is protected laterally but also protects the integrity of the conjoint and semimembranosus tendons rather than dissecting through them (Figure 3).

Posterolateral and Posteromedial Portal and Retracting Suture Placement

With the sciatic nerve retracted and the scope in the AP portal, a posterolateral (PL) portal is created under direct visualization with a spinal needle using outside-in technique. It is placed ~5 cm lateral to the AD portal within the gluteal fold. Next, a posteromedial (PM) portal is created under direct visualization with a spinal needle using outside-in technique. It is placed ~5 cm medial to the AD portal within the gluteal fold. The switching stick is then placed in the PM portal and used to carefully retract the sciatic nerve further laterally and anteriorly. A radiofrequency probe is placed in the AD portal to clean out fatty tissue and further define the space.

Gluteus maximus retraction sutures are then placed. A nonabsorbable suture is looped at its midpoint, and the looped end is inserted through the AD portal and retrieved from the PL portal. Outside the body, the nonlooped end is inserted through the retrieved looped end in a cinch fashion and pulled taut at the skin level to retract tissue. The scope is placed in the PL portal using a switching stick and second trochar as done previously. A second nonabsorbable suture is looped at

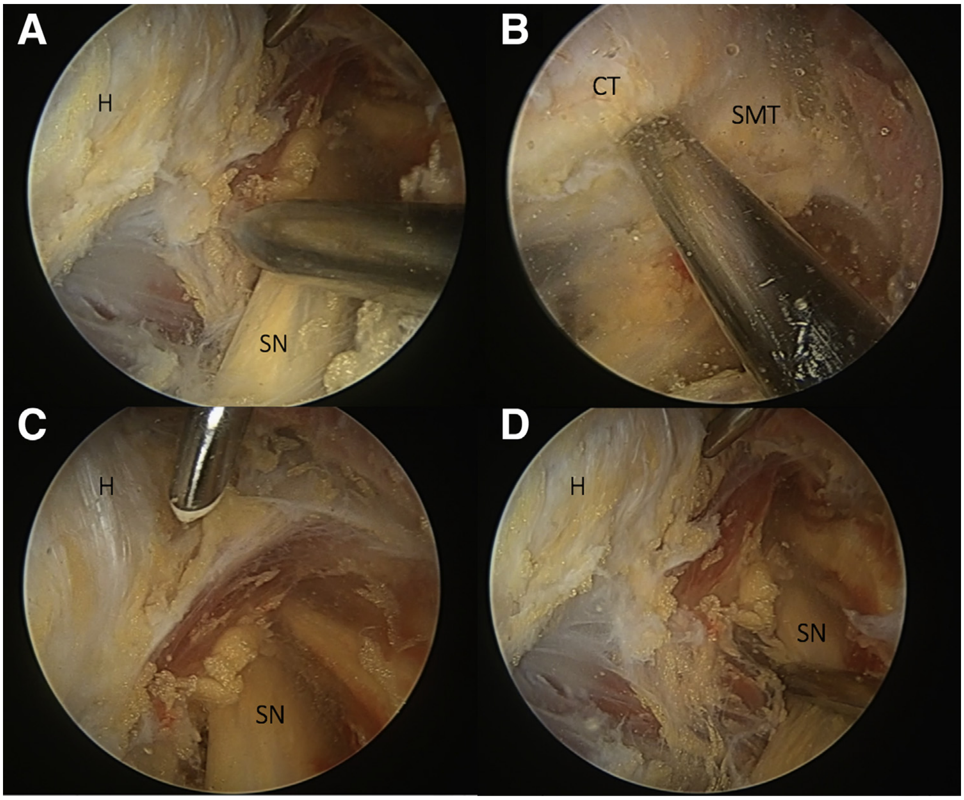

Figure 3. Exposure. Endoscopic visualization of a right hamstring repair through the posterolateral portal with the patient positioned prone. (*A*) The hamstring insertion at the ischial tuberosity and sciatic nerve more laterally are identified. The sciatic nerve is probed and gently mobilized away from the operative field. (*B*) The proximal hamstring insertion is examined, and the interval between the conjoint and semimembranosus tendon is probed. Mobility of the tendons indicates a tear and can assist in the diagnosis and severity assessment. (*C*) Blunt dissection with a switching stick or probe and radiofrequency ablation are used to develop the interval between the hamstring origin at the ischial tuberosity and the sciatic nerve. Radiofrequency ablation is also used to clear adhesions and fatty tissue surrounding the sciatic nerve and proximal hamstring origin. (*D*) Once the sciatic nerve is identified and dissected with good mobilization, the nerve is mobilized to allow access for a safe tendon repair. The switching stick placed in the accessory distal (AD) portal is used to carefully retract the nerve laterally and anteriorly, away from the surgical field. CT, conjoint tendon; H, hamstring; SMT, semimembranosus tendon; SN, sciatic nerve.

its midpoint and the looped end inserted through the AD, but this time retrieved from the AP portal. Again, the nonlooped end is inserted through the retrieved looped end in a cinch fashion and pulled taut at the skin level. This creates 2 retraction sutures: 1 from the AD to PL portal and 1 from the AD to AP portal, helping

Table 2. Portal placement and function

Portal	Location	Function
Accessory distal (AD)	~1 cm immediately lateral to the ischial tuberosity and in line with the gluteal fold	Starting portal, viewing and working portal, initial dissection, footprint preparation, anchor placement
Accessory proximal (AP)	~5-10 cm proximal to the AD portal	Second portal, primary viewing portal, working portal, retraction sutures
Posterolateral (PL)	~5 cm lateral to the AD portal within the gluteal fold	Viewing and working portal, anchor placement, retraction sutures
Posteromedial (PM)	~5 cm medial to the AD portal within the gluteal fold	Working portal, sciatic nerve retraction

In general, 4 portals are created, 3 within the gluteal crease. The AP, AD, and PL are the viewing portals. All portals are used at difference times in the case as working portals: AD for the initial dissection; PM, AD, and PL for sciatic nerve retraction; AP and PL for retraction suture retrieval; AD for preparation of the footprint; and AP and PL for anchor placement. Although these are the recommended locations for portal placement, they may vary slightly based on the individual patient's anatomy and should be created at the discretion of the surgeon. Both the AP and AD portals should be in vertical alignment within the interval between the hamstring tendon and sciatic nerve.

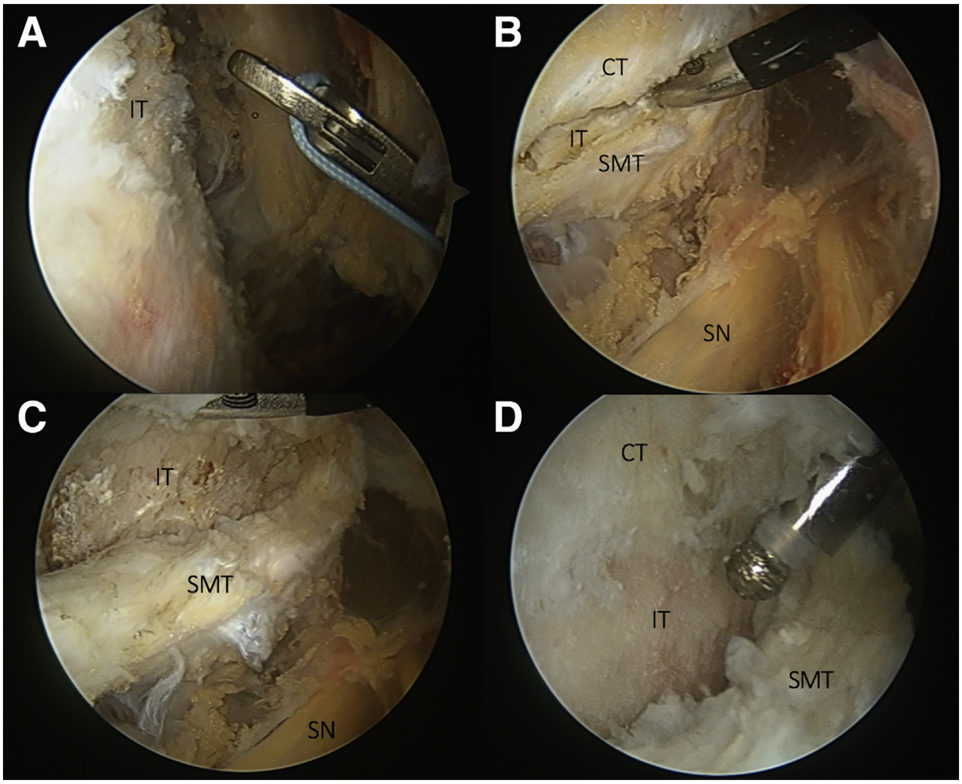

Figure 4. Retraction sutures and tuberosity preparation. Endoscopic visualization of a right hamstring repair through the posterolateral portal with the patient positioned prone. (*A*) Once the sciatic nerve is adequately mobile, retraction sutures are placed. A nonabsorbable suture is looped at its midpoint, and the looped end is inserted through the accessory distal (AD) portal and retrieved from the posterolateral (PL) portal as shown in the figure. Outside the body, the nonlooped end is inserted through the retrieved looped end in a cinch fashion and pulled taut at the skin level to retract tissue. These steps are repeated from the AD to accessory proximal (AP) portal. This creates 2 retraction sutures: 1 from the AD to PL portal and 1 from the AD to AP portal, helping retract the gluteus maximus and protect the exposure. (B) The tear is accessed through the conjoint tendon and semimembranosus interval to facilitate repair of the entire footprint. (C) Using radiofrequency ablation, dissection is carried down to the ischial tuberosity in the interval between the conjoint and semimembranosus tendons, and the footprint is detached in its entirety. (D) An endoscopic burr is used to carefully decorticate the ischial tuberosity to promote healing. CT, conjoint tendon; H, hamstring; IT, ischial tuberosity; SMT, semimembranosus tendon; SN, sciatic nerve.

retract the gluteus maximus and to protect the exposure. We find that the addition of these sutures provides excellent visualization throughout the procedure. See Table 2 for a summary of portal placement and function (Figure 4).

Footprint Preparation

The camera is returned to the AP portal. An endoscopic burr is placed in the AD portal, and the ischial tuberosity is carefully decorticated to promote healing. An endoscopic grasper may be placed in the PL portal to retract the tendon if necessary. Next, the Phoenix microfracture system is used to further prepare the footprint through the AD portal (Figure 4).

Anchor Placement and Suture Repair

With the camera in the AP portal, 4 triple-loaded anchors are placed, 2 in each tendon footprint (conjoint tendon, semimembranosus tendon). The endoscopic grasper is used through the AD portal, and the anchors are placed through the PL and AP portals. During placement of the anchors, the grasper is used to reflect the tendon. Mattress stitches are passed through each tendon, but also 1 from each anchor through both tendons to close the interval and further compress the tendon to the footprint. After placement of the anchors, the tendon is reduced, and a Slingshot suture passer is placed from outside in. This also prevents inadvertent injury to the nerve.

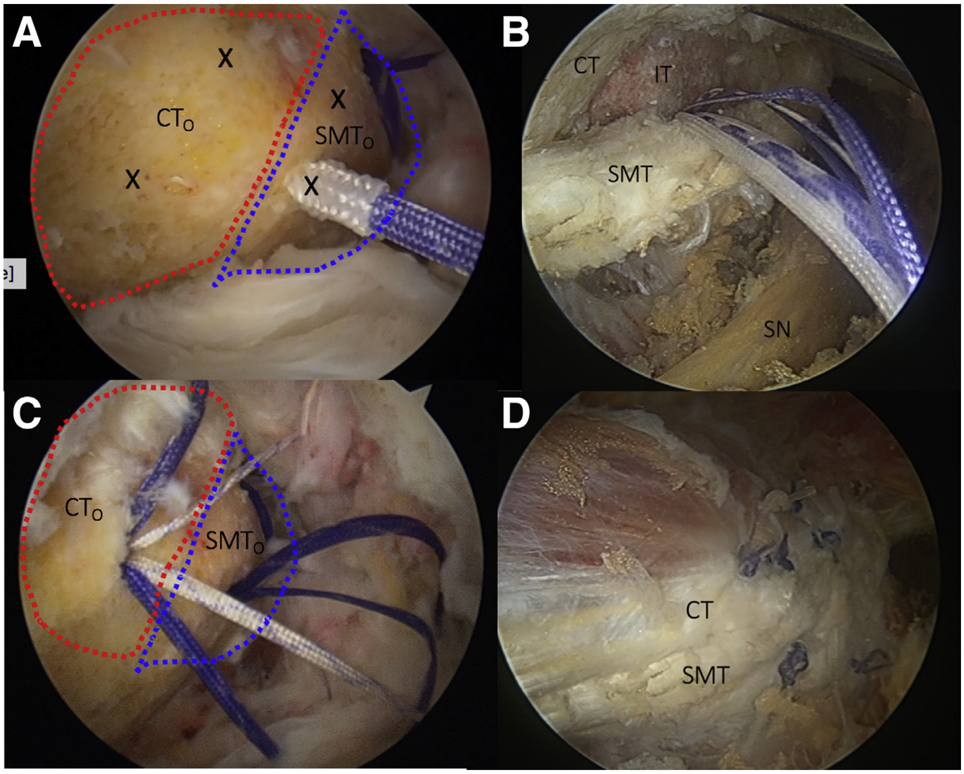

Figure 5. Anchor placement and suture repair. Endoscopic visualization of a right hamstring repair through the posterolateral portal with the patient positioned prone. (*A*) The first suture anchor is placed. The red outline represents the conjoint tendon footprint, and the blue outline represents the semimembranosus tendon footprint. The X's indicate the target suture anchor placement. (*B*) The semimembranosus tendon is reflected back to its footprint, confirming proper anchor placement for anatomic repair. (*C*) Additional anchors are placed for a total of 4: 2 at the footprint of the conjoint tendon and 2 at the footprint of the semimembranosus tendon. A double row configuration is created. After placement of the anchors, the tendon is reduced, and a Slingshot (Stryker) suture passer is placed from outside in. A horizontal mattress configuration is created for each suture. Once all sutures have been passed, the knots are tied arthroscopically through a transport cannula. (D) The final repair is visualized with anatomic restoration of both the conjoint and semimembranosus tendons to the ischial tuberosity. CT, conjoint tendon; CT_O, conjoint tendon origin; IT, ischial tuberosity; SMT, semimembranosus tendon; SMT_O, semimembranosus tendon origin; SN, sciatic nerve.

Once the tendon is penetrated, the tendon is reflected, and the appropriate suture limb is retrieved through the PL portal. The sutures are retrieved around the switching stick. A horizontal mattress configuration is created for each suture. Once all sutures have been passed, a transport cannula (Stryker) is placed in the PL portal, and knots are tied arthroscopically. Suture typing occurs only after all suture limbs from all the anchors have been passed to allow free motion of the tendon, which facilitates proper suture passing. Finally, the nerve is confirmed to be intact. The arthroscope is removed from the space (Figure 5).

Closure

The wound is closed with a deep subdermal layer and the skin approximated with 3-0 nylon sutures.

Postoperative Protocol

The patient is given a prefabricated, custom brace to keep their knee at flexion to 50° at night only (the brace is not used during the day). The patient is nonweightbearing for 6 weeks, but while ambulating there is no knee extension limitation. It is our experience that when patients strive to keep their knee flexed during mobilization, more tension is transferred to the hamstring than letting the leg hang naturally. We do recommend resting with the knee flexed at least 50°. The patient is allowed to progress to running at 3 months. Return to sport-specific activities begins at 4 months.

Discussion

Both open and endoscopic surgical approaches to hamstring repairs have advantages over conservative

Table 3. Potential dangers of the technique

Danger	Location	Surgical anatomy
Sciatic nerve	1.2 cm lateral to ischial tuberosity[13]	Lies lateral and anterior (deep in incision) to proximal hamstring tendons
Posterior femoral cutaneous branch	Branches above ischial tuberosity and travels laterally in subcutaneous tissue in gluteal fold	Found in subcutaneous tissue and can be traced back to identify sciatic nerve
Inferior gluteal nerve and artery	5 cm proximal to ischial tuberosity	Lies deep to gluteus maximus
Medial femoral circumflex artery	Arises from the medial aspect of the profunda femoris and travels laterally and posteriorly around the femoral neck	May be at risk when retrieving the retracted tendon distally

management but are also associated with concomitant risks related to the anatomic proximity to the perineum, sciatic nerve, and other posterior structures.

General Complications of Hamstring Injuries

General complications after a hamstring injury regardless of management include weakness in knee flexion and hip extension, hamstring syndrome (posterior buttock and ischial tuberosity pain), and sciatic neuralgia. A recent systematic review of operative and nonoperative treatment of hamstring avulsions reported an overall complication rate of 23.17% with open operative intervention.[8] The complications included rerupture, reoperation, infection and wound complications, neurologic complications, peri-incisional numbness, and deep venous thrombosis (DVT). Other neurovascular structures at risk during any hamstring surgery are the posterior femoral cutaneous branch, inferior gluteal nerve and artery, and medial femoral circumflex artery (Table 3).

Advantages and Limitations of the Technique

The endoscopic surgical technique described here is modified from previously published techniques[1-5] with unique positioning, portal placement, dissection and exposure, protection of the sciatic nerve, and anatomic tendon repair (Table 4). Similar to the previously described endoscopic techniques, our technique is advantageous for many reasons inherent to endoscopic surgery. The minimal soft tissue disruption theoretically decreases the risk of infection and wound complications, peri-incisional numbness, and DVT or pulmonary embolism, owing to earlier mobilization.

There are many advantages specific to our approach that warrant consideration over previously described techniques. There are multiple measures taken to ensure protection of the sciatic nerve. First, our unique prone positioning, with the feet at the elevated head of the bed, and subsequent knee flexion to 90° decreases the stretch on the sciatic nerve, allowing improved mobilization and protection. The table positioning also

Table 4. Advantages and disadvantages of the technique

Advantages	Disadvantages
Positioning: The feet positioned at head of the bed allow the leg to be stabilized with knees at 90°, thus decreasing stretch on the sciatic nerve.	Difficulty or inability to mobilize large, retracted chronic hamstring tears
Approach: Limited incisions and soft tissue violation decrease the risk of infection and wound complications.	Learning curve of the technique
Safety of portal establishment: After initial AD portal, all portals are made under direct visualization.	
Sciatic nerve protection includes the following: • Positioning; • Portal placement under direct visualization; • Identification, dissection, mobilization; • Dissection within conjoint and semimembranosus interval; • Retraction sutures; and • Nonsterile assistant monitoring patient's foot.	
Exposure: Dissection within the interval between conjoint and semimembranosus tendons takes advantage of natural anatomic interval of the 2 tendons and allows for an anatomic repair.	Dissection outside of this interval puts the sciatic nerve at risk as well as potential violation of intact hamstring tendon.
Anatomic repair: 4 anchors total, 2 at the conjoint tendon footprint and 2 at the semimembranosus footprint • Pearl: To repair the semimembranosus tendon, its origin must be accessed at the anterolateral aspect of ischium. Thus, to safely pass sutures and ensure a complete, anatomic repair, the sciatic nerve must be mobilized (not merely identified).	
Cost: No need for fluoroscopy or neuromonitoring	

stabilizes the operative limb rather than the previously described flat prone positioning and free leg. In addition, having a nonsterile assistant with a hand on the patient's operative foot throughout the entirety of the case ensures no unintentional activation of the sciatic nerve, but also avoids the cost and complexity of formal nerve monitoring. After the initial AD portal is placed using palpation and tactile sensation, the remainder of the portals are established under direct visualization. This allows the procedure to be safely performed without the necessity of fluoroscopy as recommended in previous techniques.[1,3-5] It is imperative to facilitate anatomic repair that the dissection remains within the interval between the conjoint and semimembranosus tendons and is carried out in vertical, parallel alignment with the sciatic nerve and hamstring tendons. Additionally, the retraction sutures further protect the sciatic nerve and allow excellent visualization during tendon repair and anchor placement. These measures taken to ensure protection of the sciatic nerve avoid the need for neuromonitoring suggested by Gomez-Hoyos et al.[5]

There are multiple risks and limitations to this technique. Similar to any arthroscopy procedure, the limited exposure and visualization creates a risk for damage to surrounding neurovascular structures. There are many important posterior structures that are at risk during dissection, as outlined in Table 3. We advocate using this procedure in the setting of both acute, full-thickness, minimally retracted tendon tears as well as chronic, partial-thickness tears or tendinosis. However, the adhesions associated with chronic injuries impose a more challenging dissection and place these posterior structures at an even higher risk. Careful attention must be paid during portal placement and manipulation for patients with chronic ruptures because of early fibrosis and altered anatomy around the sciatic nerve.[12] The fibrosis present in chronic injuries may cause challenges with endoscopic visualization, necessitating an open procedure.

Another disadvantage to endoscopic repair is difficulty or inability to mobilize large, retracted hamstring tears. This is especially important in the setting of chronic injuries. Lastly, the learning curve of the technique can be challenging to overcome if the volume of these injuries is low in an individual surgeon's practice.

Although both acute and chronic degenerative hamstring injuries are very common, operative indications are not well described, and there are currently no level I or II randomized prospective studies available comparing operative versus nonoperative management. Although open surgical repair with suture anchors has been the gold standard when surgical intervention is warranted, endoscopic techniques offer many benefits including better access, a more anatomic repair, and decreased complications. This unique endoscopic technique has modifications to increase protection of the sciatic nerve, allow for an anatomic repair, and decrease resources and cost. The detailed, step-by-step instructions will allow novice surgeons to adopt this technique.

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