Technical Note

Repair of Retracted Hamstring Tears with Hamstring Pulley Technique and Inferomedial Portal

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Abstract: Endoscopic repair of hamstring tears is well described in the literature, but endoscopic management for significantly retracted hamstring tears is not well described. Currently, repairing a hamstring tendon that has retracted 8 cm or more from the footprint on the ischial tuberosity is performed as an open procedure. The technique described here details endoscopic repair of retracted hamstring tears using a suture pulley mechanism and an inferomedial portal.

With the advent and further refinement of hip arthroscopy has come the endoscopic management of several pathologies that were treated previously with more-invasive approaches.[1-3] Several advancements have been made since Dierckman and Guanche first developed a technique that allows for the endoscopic management of proximal hamstring tears and chronic ischial bursitis.[4] These endoscopic techniques have shown excellent short-term outcomes in the literature with regards to return to function and resolution of pain.[5-7]

Although endoscopic management of proximal hamstring tears is now well-described in the literature, to our knowledge, there are no descriptions of endoscopic management for significantly retracted hamstring tears, which will be defined as tears >8 cm for the purposes of this technique. Repairing these injuries endoscopically has been a significant challenge for surgeons. The authors have developed modifications to endoscopic hamstring repairs that use an innovative shuttling technique and portal placement to allow for approximation and fixation of significantly retracted tendon tears.

Hamstring injuries are common in athletic populations and can affect all levels of athletes.[8-11] There is a continuum of hamstring injuries that can range from musculotendinous strains to avulsion injuries.[8] By definition, a strain is a partial or complete disruption of the musculotendinous unit.[8] A complete tear or avulsion, in contrast, is a discontinuity of the tendon—bone unit. When the torn or avulsed tendon is severely retracted, either acutely or due to chronicity of a smaller tear, open operative intervention has historically been the only course of management.[8-11]

The proximal hamstring complex has a strong bony attachment on the ischial tuberosity. Its footprint on the ischium is composed of the semitendinosus and long head of the biceps femoris beginning as a common proximal tendon and footprint, whereas there is a distinct and separate semimembranosus footprint.[12] The semimembranosus footprint is just lateral (and anterior) to the crescent-shaped footprint of the common origin of the semitendinosus and long head of the biceps femoris.

The history of an acute injury usually involves a traumatic event with forced hip flexion and the knee in extension, as is classically observed in waterskiing.[13,14] However, the injury can result from a wide variety of sporting activities that require rapid acceleration and deceleration.[15,16] The authors note that there is a significant population of aging adults with non-traumatic, partial tears that are associated with degeneration or ischiofemoral impingement.[17]

Commonly, athletes with proximal hamstring tendon tears describe a popping or tearing sensation with

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The authors report the following potential conflicts of interest or sources of funding: J.L. reports paid consultant, speaker, and royalties from Conmed Linvatec; paid consultant and speaker from Smith & Nephew; editorial board, Journal of Hip Preservation and Arthroscopy*; and committee member,* AANA. *All other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

Received May 10, 2023; accepted July 30, 2023.

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2212-6287/23667

https://doi.org/10.1016/j.eats.2023.07.057

associated acute pain and bruising over the posterior hip.[18,19] Occasionally, patients who present with either acute or chronic tears may complain of a pins-and-needles sensation in the sciatic nerve distribution, much like sciatica.[19,20] This may be due to the acute compression of a hematoma in the proximity of the sciatic nerve or chronic scarring and tethering of the tendon to the nerve. Similarly, symptoms of ischial bursitis include buttock pain or hip pain, as well as localized tenderness overlying the ischial tuberosity. Additional symptoms of chronic ischial bursitis may also include tingling into the buttock that spreads down the leg.[19]

The development of endoscopic hamstring repair provides a minimally invasive and effective intervention to improve the management of severely retracted proximal hamstring injuries and reduce the morbidities associated with open approaches.[5] The technique in this paper describes a suture anchor pulley technique that allows for re-approximation of the retracted tendon and introduces a portal that simplifies suture management in the instance of such tears.

Surgical Technique (With Video Illustration)

We describe a detailed technique of the procedure shown in Video 1. Patient setup and establishment of portals are no different for a completely retracted, traumatic hamstring tear when compared with the approach for intact partial-thickness tears. There is an additional inferomedial portal that may be used in the event of a significantly retracted hamstring beyond the capability of instrumentation.

Appropriate table positioning is critical, as it creates a variety of advantages for the surgeon. A standard operating table is rotated 180° to position the head of the table at the foot in relation to the patient. The patient is brought into the operating room and placed under general anesthesia while on the cart. Patient is then log rolled into a prone position on a normal surgical table with chest rolls in place. Anesthesia takes extra care to maintain the position of the endotracheal tube to ensure proper placement. The feet should hang freely over the foot of the operative table, and all bony prominences and neurovascular structures should be protected with appropriate padding.

The patient is secured with chest straps while the arms are placed on arm boards in a comfortable overhead position with the shoulder and elbow at 90° to prevent injury to the brachial plexus. The nonoperative leg is likewise secured using a safety strap. Two separate arm boards are placed sided by side at the level of the operative hip, angled at 45° away from the bed. The operative leg will be placed on the arm boards as to produce approximately 30° to 45° of abduction, depending on patient laxity (Fig 1). At this time, care must be taken to avoid excessive hip flexion, and adjustments should be performed as necessary. Hip flexion may decrease the volume of subgluteal space and ultimately limit the endoscopic working environment.

The table is tilted approximately 15° toward the contralateral side placing the inferior ramus in the same plane as the ischium. The patient is then initially draped with a U-drape that originates from underneath the extremity and a 10/10 over top. Fluoroscopy should enter from the opposite side of the operative extremity. The C-arm is centered over the ischium and arced slightly over the top of the patient. The combined 15° tilt of the table and position of the C-arm creates an en face radiographic image of the ischium.

The abduction of the operative extremity draws the sciatic nerve lateral to the ischium in a safer position as described by Kivlan et al.,[21] who demonstrated the dynamic nature of the ischiofemoral space during rotational movement of the hip joint. Abduction of the operative extremity also permits easier access to the medial portal compared with previous techniques and maintains the operative extremity in a more neutral or adducted position.

The posterior hip is then sterilized, with the surgeon ensuring that the leg and thigh are free so the extremity can be manipulated during the case. The surgeon then positions him-/herself ergonomically between the leg and operative table, which creates a more intuitive orientation for the surgeon in relationship to the anatomy.

The midcentral portal is created under fluoroscopic guidance using an 18-gauge spinal needle for localization (Fig 2).[22] The ischium is palpated with one hand while the other hand guides the needle distal to the gluteal fold in line with the ischium, taking care to note the oblique nature of the ischium. Once the needle encounters the ischium, the position is verified with fluoroscopy and the portal is created. It is critical that the tip of the needle be centered on the ischium from both a superior—inferior and medial—lateral location.

Once the portal is created, a cannula is placed. Using tactile sensation, the cannula is passed into the subgluteal space and swept medial to lateral over the ischium. This should create a small pocket within the subgluteal bursa allowing for the establishment of the medial portal. One should avoid sweeping lateral to the ischium, as this may put the sciatic nerve at risk. Use of a 30° arthroscope is sufficient for this procedure and will be inserted through the midcentral portal.

The medial portal is established using direct endoscopic needle localization and visualization through the scope. The needle is replaced with the Wissinger rod or reciprocating shaver, making sure to penetrate through the gluteus maximus fascia to maintain proper fluid pressure control and hemostasis. If penetration is

Fig 1. Operating room setup for an endoscopic hamstring repair. Setup is a normal bed with the head at the foot and 2 armboards placed at 45° on the side of the operative limb. The operative leg is placed on the 2 armboards and the resulting abduction draws the sciatic nerve away from the operative field.

completed through the gluteus maximus fascia with the Wissinger rod, it can be replaced with a reciprocating shaver.

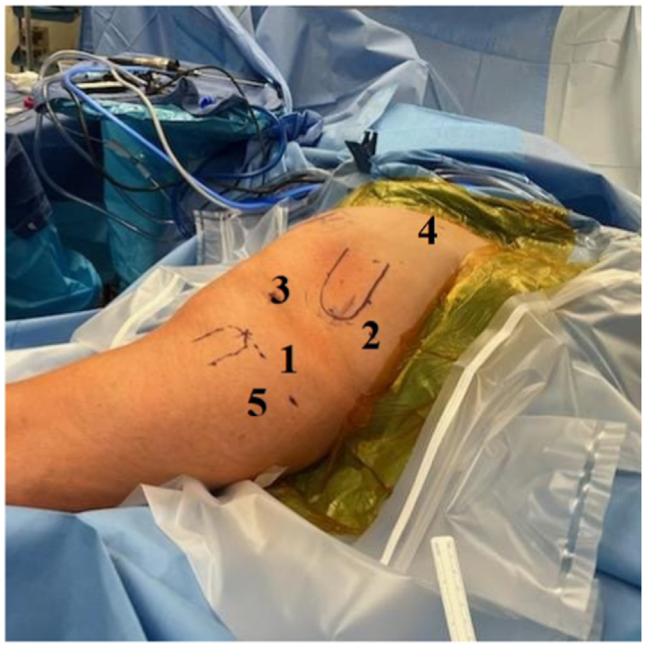

Fig 2. Image depicting appropriate portal placement for left hamstring repair. 1, Midcentral portal; 2, medial portal; 3, lateral portal; 4, suture management portal; and 5, inferomedial portal. The patient is positioned prone with left leg in abduction.

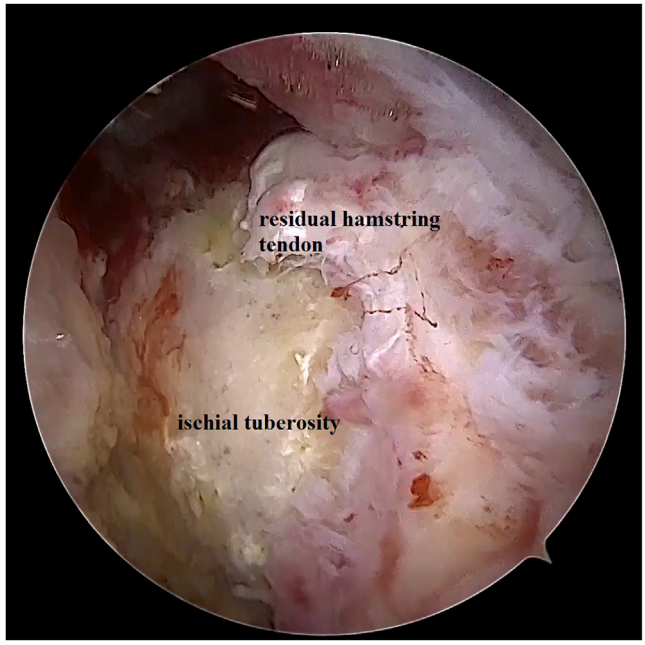

Fig 3. Intraoperative view of the bare hamstring footprint on the ischial tuberosity from the midcentral portal on the left lower extremity during endoscopic hamstring repair. The patient is positioned prone with left leg in abduction, the midcentral viewing portal is located distal to the gluteal fold in line with the ischium

At this point, a full thickness retracted hamstring will have a vast amount of hematoma and scar tissue formation. It is imperative to maintain the basic principles

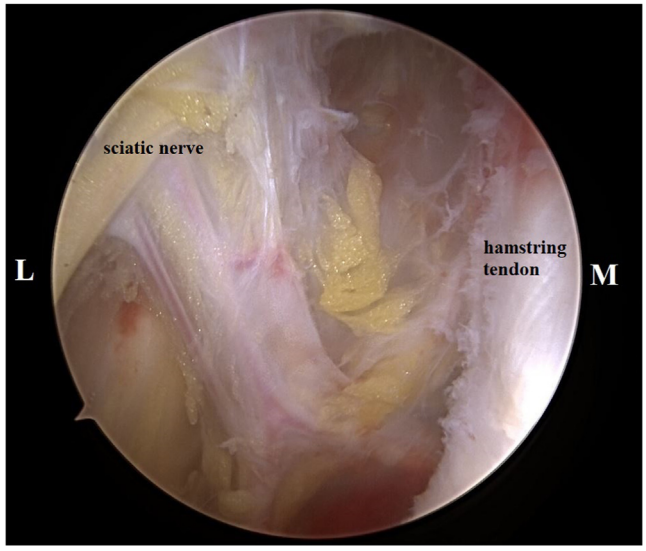

Fig 4. Intraoperative image of the sciatic and posterior femoral cutaneous nerves and associated vascular bundle as seen from the midcentral portal (located distal to the gluteal fold in line with the ischium) on the left lower extremity during endoscopic hamstring tendon repair. The patient is positioned prone with left leg in abduction, which draws these structures away from the operative field. The surgeon, however, must remain vigilant of their proximity.

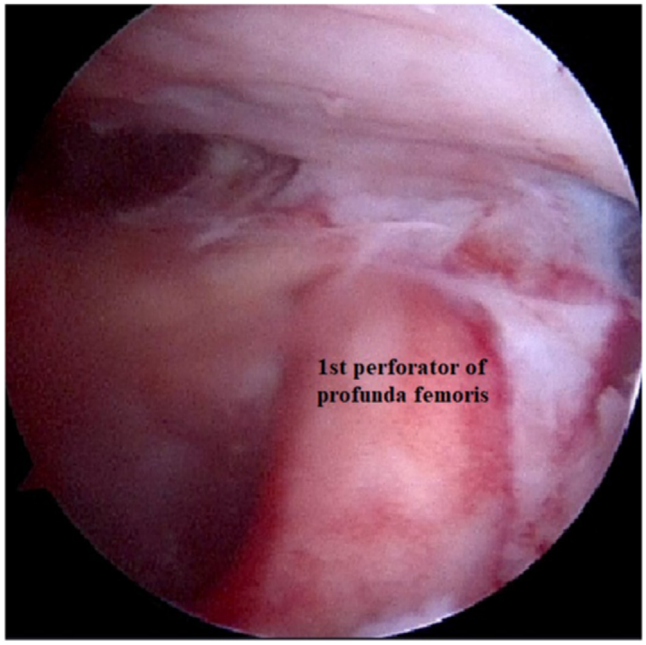

Fig 5. The first perforating branch of the profunda femoris artery sitting lateral to the hamstring tendon sheath viewed from the midcentral portal on the left lower extremity during an endoscopic hamstring repair. This is a significant danger during the operation and, thus, surgeons must be on the lookout for this structure. The patient is positioned prone with left leg in abduction, the midcentral viewing portal is located distal to the gluteal fold in line with the ischium.

of arthroscopy, as poor visualization can place the sciatic nerve at risk, since it has yet to be identified.

Next, resection of the scar tissue and blood clots allows for visualization of the bare ischial tuberosity proximally (Fig 3) and opens up the subgluteal space for identification of nerves and arteries that may be impeding the field as well as the location of the hamstring stump distally. At this point, the sciatic nerve may be dissected. It should be stressed that adequate hemostasis is paramount before dissection of the sciatic nerve is performed. A veil of adipose tissue will be encountered, which harbors the posterior femoral cutaneous nerve and sciatic nerve. The nerve is expected to be safely located several centimeters lateral to the ischium with the hip abducted (Fig 4).[23] This tissue is carefully freed using a gentle proximal to distal sweeping technique with a Wissinger rod. Very careful and methodical release of any soft-tissue bands is then undertaken in a proximal to distal fashion to mobilize the nerve and protect it throughout the exposure and repair of the hamstring tendon.

When working more distally in the tendon sheath, the medial femoral circumflex artery and the first perforating branch of the profunda femoris also can be encountered lateral to the endoscopic working environment. These structures do not need to be consciously isolated, but surgeons should be aware of their proximity (Figs 5 and 6).[23]

The reciprocating shaver may be used to extend the sheath opening distally until the stump is identified. Once the stump is identified, the shaver can be used for blunt dissection to free up the hamstring and to remove devitalized tissue from stump, as to expose healthy tendon tissue. After adequate dissection of the stump, the ischium can begin to get prepped with the shaver to remove remnant tissue and allow for fresh bleeding cortical bone.

Next, the lateral portal is established using direct endoscopic needle localization. The final position should optimize access to the entire ischium and subgluteal bursa as well as the placement of anchors into the ischium. A single or double loaded vented anchor or all-suture anchor may then be placed into the most distal aspect of the ischium for the use as a retraction suture (Fig 7). The authors prefer a 2.8-mm double-loaded Q-Fix suture anchor (Smith & Nephew, Andover, MA). The suture is passed through a generous portion of the stump as to be certain it will not pull through while applying traction (Fig 8).

In the event of a significantly retracted hamstring (>8 cm), the authors describe an inferomedial portal (Fig 2) that may be placed so that instrumentation can be used to continue dissection and pass/receive the reaction suture.

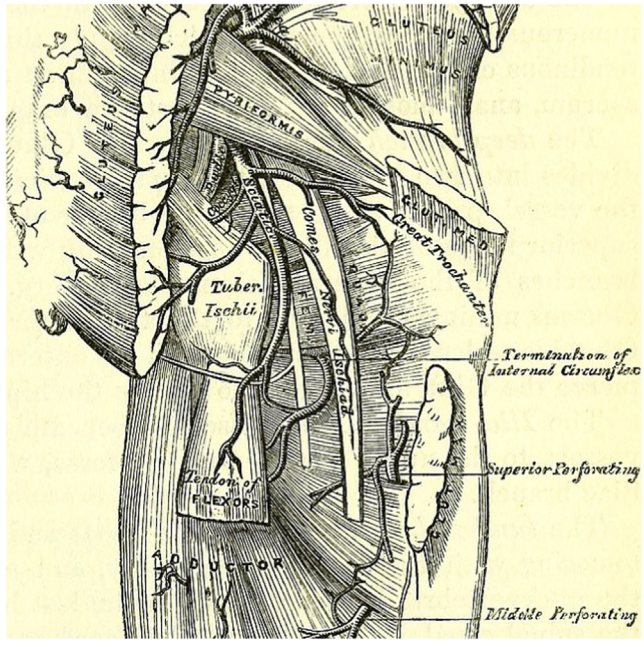

Fig 6. An illustration by Dr. Henry Gray of the posterior thigh demonstrating the dangers surrounding the hamstring sheath. From medial to lateral are the inferior gluteal artery, posterior femoral cutaneous nerve, sciatic nerve, medial circumflex femoral artery, and the first perforating branch of the profunda femoris artery.[23]

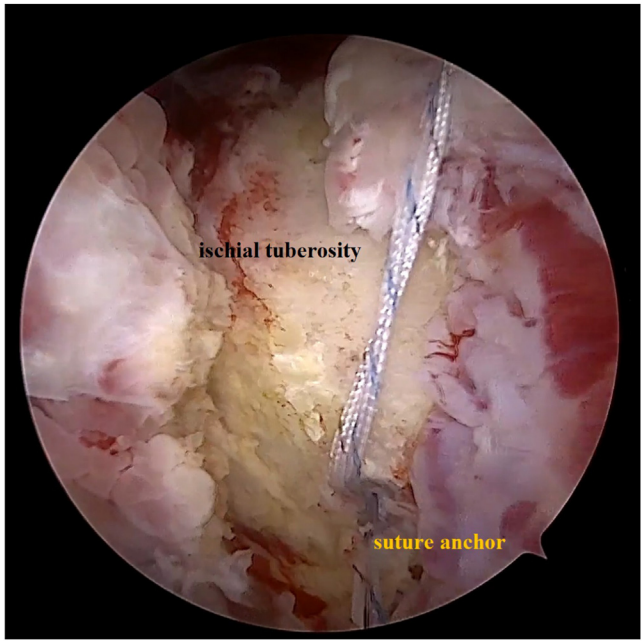

Fig 7. A pulley suture anchor placed in the distal most aspect of the ischial tuberosity as viewed from the midcentral portal on the left lower extremity during endoscopic hamstring repair. The most superior suture tracks proximally through the superior suture management portal. The function of this suture anchor is to approximate the retracted hamstring tendon to its footprint on the ischial tuberosity. The patient is positioned prone with left leg in abduction. The midcentral viewing portal is located distal to the gluteal fold in line with the ischium.

At this point, the suture management portal will be established to at the superior most aspect of the subgluteal space as to allow for an axial line of pull to retract the tendon towards the ischium. While gentle traction is applied to the tendon, dissection of any scar tissue that may be tethering down the stump may be continued (Fig 9). Once the tendon is relatively free and reduces appropriately, triple-loaded vented suture anchors may be inserted into the ischium and the sutures may be passed through the tendon, posteriorly to the placement of the anchors. The authors prefer Alpha-Vent 4.75-mm triple-loaded PEEK suture anchor with 1.8-mm suture tape (Stryker Corporation, Greenwood Village, CO) or 4.5-mm Mitek Healix Advance PK triple-loaded DYNACORD suture anchor (Depuy Mitek, Inc., Raynham, MA). After a set of sutures from one anchor has been passed, the sutures will be pulled through the SMP portal for organization and to prevent any entanglements.

At this point, it is imperative to identify the sutures that been passed in comparison with the sutures that are coming directly from the anchor (Fig 10). Once the suture limbs coming direction from the anchor have been identified, they may be clipped with a hemostat and placed on the skin. The remaining suture limbs that have been passed through the tendon also will be clipped with another hemostat and will be used as the primary retraction set for the remainder of the case. The final set of sutures may be appropriately passed from the remain 1 or 2 other anchors per surgeon preference and space available at the ischium.

Once all sutures have been passed, the knee will be flexed to 90° and final traction will be placed on the hamstring with full reduction and tying of knots with a sliding knot, preferentially the SMC knot with 2 alternating half-hitches. Once all knots are tied, the knee is relaxed to evaluate stress at the repair site (Fig 11). The subgluteal space and sciatic nerve can continue to be debrided of remaining scar tissue and clot formation. A spinal needle is then inserted in the subgluteal space to bathe the repair with a local anesthetic. Remaining arthroscopic fluid is suctioned from the space and incisions are closed using MONOCRYL (Ethicon, Cornelia, GA), skin adhesive, Steri-Strips (Nexcare, Maplewood, MN), xeroform, gauze, and abdominal pads secured with foam tape.

Discussion

Although endoscopic repair for partial tears or minimally retracted tears has increased in popularity,

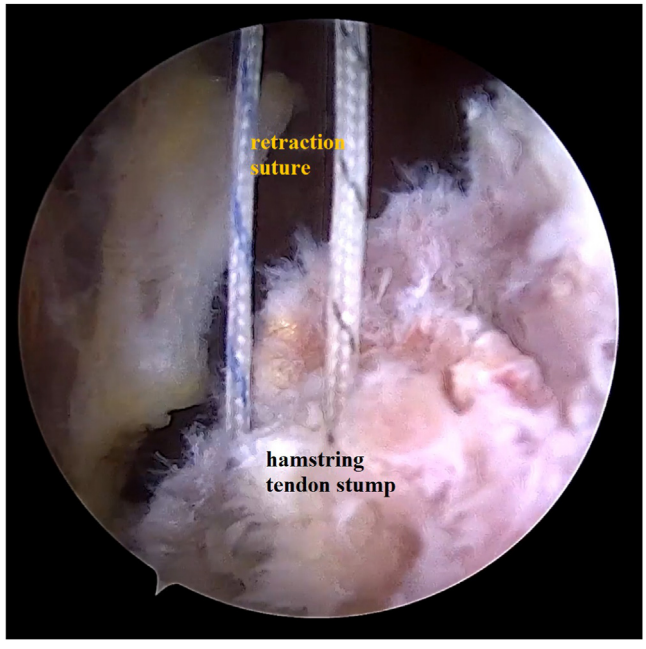

Fig 8. A retracted hamstring tendon is shuttled superiorly to the footprint on the ischium using a previously placed suture anchor as a pulley system during an endoscopic hamstring repair. View from midcentral portal on left lower extremity during endoscopic hamstring repair. The patient is positioned prone with left leg in abduction and the midcentral viewing portal is located distal to the gluteal fold in line with the ischium.

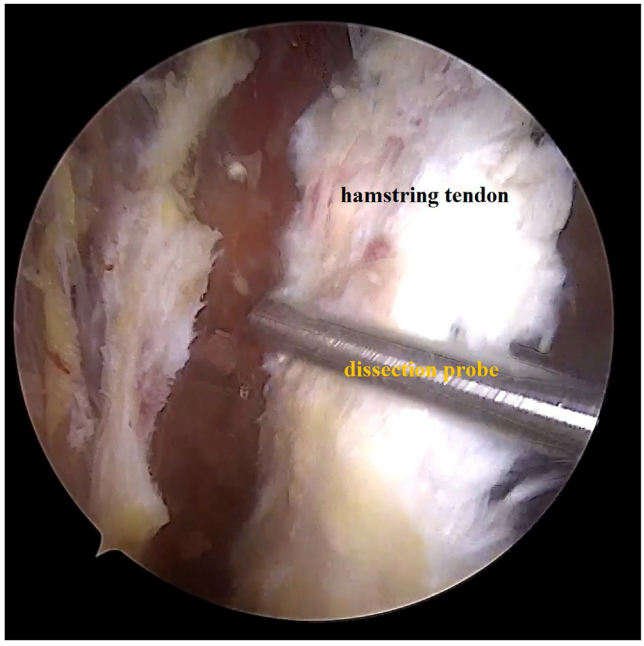

Fig 9. Dissection of soft tissue from the hamstring tendon stump is continued as the tendon is drawn superiorly through the hamstring sheath. The instrumentation for debriding the tendon stump, shown here, and passing sutures enter through the inferomedial portal. Viewed from the midcentral portal on the left lower extremity. The patient is positioned prone with left leg in abduction and the midcentral viewing portal is located distal to the gluteal fold in line with the ischium.

severely retracted tendons have been a contraindication to endoscopic repair due to the advanced difficulty of the procedure. The advent of this technique will allow surgeons to reap the benefits of a minimally invasive repair when treating these types of tears. Tables 1 and 2 outline the "Pearls and Pitfalls" as well as the advantages and disadvantages of the technique.

The literature has reported complication rates as high as 23% in open methods of hamstring repair.[24] The proximity to the perineal region increases the risk for superficial as well as deep wound infections, which was found to be about 3% in one study.[25] The endoscopic technique substantially diminishes this possibility. Furthermore, this minimally invasive technique provides improved cosmesis over open approaches.

There are some risks of surgical repair of proximal hamstring ruptures cannot be avoided with this technique. The posterior femoral cutaneous, inferior gluteal, lesser saphenous, and sciatic nerves are the main nervous structures at risk of iatrogenic injury when working near the hamstring origin.[26,27] The sciatic nerve is in close proximity to the ischial tuberosity, running along its lateral aspect. However, the dynamic nature of the ischiofemoral space during rotational movement of the hip joint can further protect the sciatic nerve. Hip abduction of the operative extremity during the endoscopic technique as described above drapes the nerve further away from the ischium, thus protecting even more during surgery.[21]

A concern unique to the endoscopic approach is fluid extravasation into the pelvis secondary to the fluid used in the distension of the potential space around the hamstring tendon. Every effort should be made to regularly check the abdomen for any evidence of abdominal distension. Likewise, any unusual blood pressure decreases should raise concern for fluid compression from retroperitoneal extravasation. In general, an attempt should be made to maintain the fluid inflow pressures as low as is feasible for adequate visualization, and an attempt should be made to keep track of fluid ingress and egress volumes to ensure that extravasation is avoided.[4] Extravasation is monitored using the Stryker Neptune Waste Management System (Kalamazoo, MI) with outflow ports that are measured by the circulating nurse.[22] The nurse calculates the net difference between ingress and egress values every 15 minutes. This will allow detection of any gross fluid extravasation.

Other risks of this endoscopic approach include neurovascular injury as described previously, steep learning curve, sitting pain, and re-rupture. If issues arise that cannot be treated during the endoscopic approach, conversion to an open procedure is recommended.

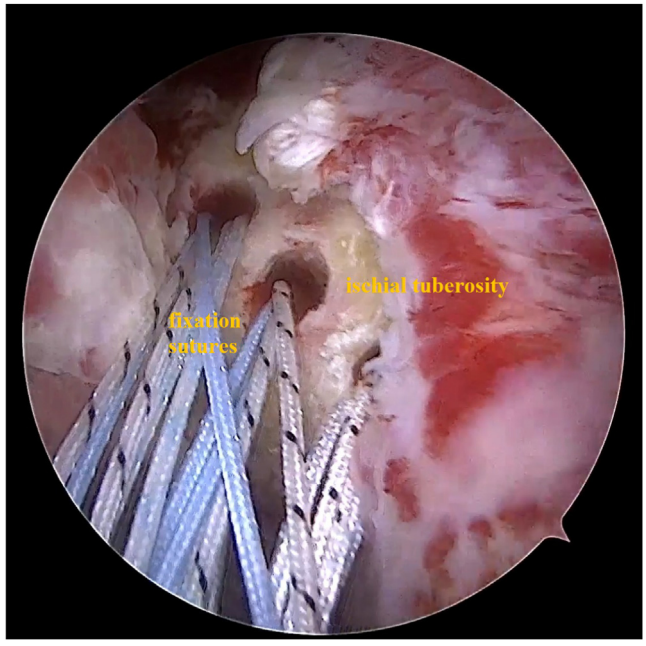

Fig 10. Three suture anchors are placed in the ischial tuberosity for the final repair of the hamstring tendon. The sutures are passed through the hamstring tendon distally. Images are from the midcentral endoscopic portal on the left lower extremity. The patient is positioned prone with left leg in abduction, the midcentral viewing portal is located distal to the gluteal fold in line with the ischium.

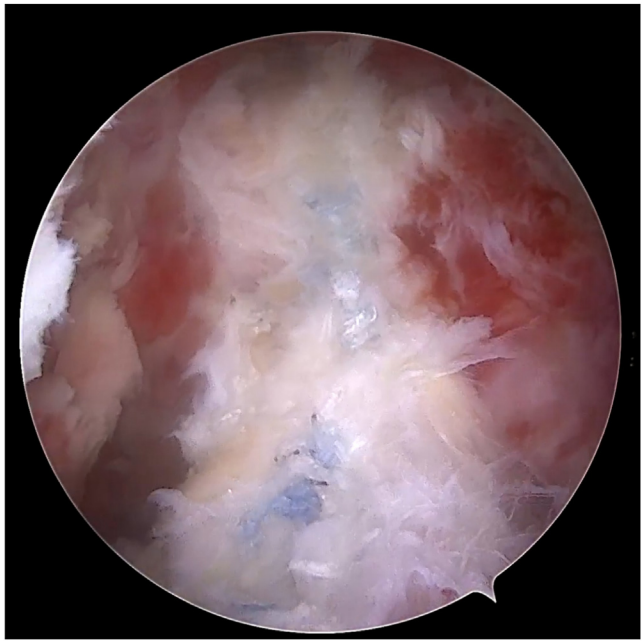

Fig 11. The final hamstring tendon repair as seen from the midcentral endoscopic viewing portal on a left lower extremity. The hip should be stressed intraoperatively in order to evaluate the integrity of the repair. The patient is positioned prone with left leg in abduction, the midcentral viewing portal is located distal to the gluteal fold in line with the ischium.

While technically advanced, the adaptability of this technique invites a wide variety of skill levels, especially newcomers who may have a low threshold to convert to an open case. The authors recommend endoscopic visualization initially. If the pathology cannot be safely treated endoscopically, simple conversion to open repair can be completed by connecting portal sites. Despite improved visualization endoscopically (especially in patients with large body habitus), these chronic full-thickness 3-tendon tears with retraction of the sciatic nerve may necessitate an open procedure.

In conclusion, hamstring tears with severely retracted tendons can be repaired endoscopically. The inferomedial portal simplifies manipulation of the tendon stump and the anchor pulley mechanism allows for approximation to the tendon footprint.

Table 1. Pearls and Pitfalls of the Technique

Pearls	Pitfalls
Proper patient position, including abduction of the hip 45° decreases risk to the sciatic nerve and increases ease of access of medial portal.	Failing to establish portals in proper orientation and trajectory.
Maintain adequate visualization and hemostasis throughout the case.	Failing to obtain adequate visualization of footprint.
Establish footprint for appropriate reapproximation of tendon repair.	Failing to maintain suture management while repairing the tendon.
Use of an additional inferomedial portal to facilitate distal instrumentation.	
Compliance of postoperative instructions while tendon is healing.	

Table 2. Advantages and Disadvantages of the Technique

Advantages	Disadvantages
Additional portal for suture management	Steep learning curve.
Reproducible technique for complex procedure	Strict patient compliance with postop restrictions required during healing phase.
Pulley suture simplifies reduction of displaced tendon to the ischial footprint	Extra retraction suture can make suture management difficult
Patient positioning to decrease risk to neurovascular structures	Technically demanding for inexperienced hip arthroscopists.
Less invasive compared with traditional open procedure	

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