Technical Note

Endoscopic Partial Proximal Hamstring Repair

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Abstract: The contemporary treatment of hamstring avulsions has been evolving, as more patients are being identified as having persistently symptomatic partial hamstring tears recalcitrant to nonoperative treatment. The endoscopic hamstring repair allows surgeons improved visualization of the footprint, as well as safe dissection of the sciatic nerve. The present technique article provides a step-by-step technical note to allow for safe and effective surgical treatment of partial hamstring tears.

Introduction

Hamstring injuries are common sports injuries, representing the most frequent reason elite athletes miss time from sports.[1] The most common type of hamstring injury is an acute strain and is typically managed conservatively. Proximal hamstring avulsions, however, are relatively rare, most commonly occurring in sports involved in rapid, explosive acceleration, such as sprinting, soccer, football, and water skiing.[2] Avulsion injuries typically occur during the end of the swing phase of the gait/running cycle, as the muscles are maximally elongated and eccentric contraction is occurring, which creates maximal tension across the proximal hamstring, while the hip is flexed, and the knee is extended.[3] Several classifications have been used to describe hamstring injuries, such as Wood et al.,[4] which based their classification on injury location, degree of avulsion (partial vs complete), extent of retraction, and presence of sciatic nerve involvement. Decision-making between conservative and surgical treatment, as well as type of surgical approach, is dependent on a variety of factors.

When considering surgery, certain factors are of paramount consideration, including tendon retraction, number of tendons involved, and the patient's sport/activity level.[5] Typical surgical indications include tendon injuries with >2 cm of retraction, 3 tendon complete injuries, and partial tendon injuries refractory to >6 months of conservative treatment. If the patient and treatment team elect to proceed with surgical repair, the decision on open versus endoscopic approaches must also be considered. Open approaches are preferred for complete and chronic tears, with greater tendon retraction, which may provide surgeons with greater exposure.[6,7] However, open repairs have been reported to have high complication rates (up to 23.2%), including infection, peri-incisional numbness, neurologic complications, revision, and sitting discomfort.[8] On the other hand, an endoscopic technique offers a minimally invasive approach and is typically indicated for patients with partial avulsions, those with minimal retraction, and those where the tendon remains under the gluteus maximus.[6,9,10] While exposure is limited, paradoxically, visualization may be improved,

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The authors report the following potential conflicts of interest or sources of funding: B.C. reports other from Smith & Nephew and Traumacad, outside the submitted work. S.J.N. reports grants from Arthrex, Allosource, Athletico, DJ Orthopaedics, Linvatec, Miomed, Smith and Nephew, and Stryker; and personal fees from Ossur, Springer, and Stryker; educational payments from Elite Orthopaedics; editorial board membership of American Journal of Orthopaedics*; and board or committee board membership in American Orthopaedic Society for Sports Medicine and Arthroscopy Association of North America. Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

Received December 30, 2022; accepted February 21, 2023.

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2212-6287/2315

https://doi.org/10.1016/j.eats.2023.02.045

particularly of the hamstring footprint on the ischium, as this may be a difficult location to view directly in larger patients. Differences in outcomes continue to be analyzed, and are currently limited in the literature, with most analyses reporting no differences between the 2 approaches. The purpose of the present technical article is to provide instruction and guidance on an endoscopic approach for a partial proximal hamstring avulsion injury.

Surgical Technique (Video 1)

Setup

The patient is placed in a prone position, with gel foams placed under the iliac crest. The limb is positioned such that the hip is extended and the knee flexed, which relaxes both the gluteus maximus muscle and the sciatic nerve (Fig 1). After standard prepping and draping, relevant landmarks are drawn out. These include the borders of the ischial tuberosity, as well as the gluteal crease. In challenging cases with less palpable landmarks, fluoroscopic guidance can be used to identify the ischial tuberosity.

Endoscopic Portal Placement

The endoscopic portals are created along the gluteal crease in the event that an open incision is required. The medial portal is the initial portal, given the proximity of the sciatic nerve to the lateral portal. It is located just medial to the lateral border of the tuberosity, and ∼2 cm distal to the distal border along the gluteal fold. The medial portal is relatively safe, so it can be made directly with blunt arthroscopic cannulas, or a spinal needle can be used to localize this portal under fluoroscopic guidance, particularly, in cases with more soft tissue interposition.

The lateral portal is then made, 3-4 cm lateral to the medial portal, also within the gluteal fold (Fig 1). The portal is made under spinal needle localization to directly visualize the instrument to avoid injury to the sciatic nerve.[11]

Anatomic Dissection

Once established, a full radius arthroscopic shaver (4.0 Smooth Bite, Stryker Endoscopy, San Jose, CA) is placed through the lateral portal, and an ischial bursectomy is performed to improve visualization and clear the subgluteal space (Fig 2). After a thorough bursectomy, the next step is to identify the hamstring tendon tear.

Tear identification can be challenging, particularly for partial-thickness tears, if the hamstring paratenon remains intact. Use the tip of the shaver or switching stick to palpate the tendon footprint against the ischium to identify the defect. The torn tendon is ballotable relative to the intact tendon. Once the defect has been identified, a radio frequency ablater (RFA) can be used to open the sheath longitudinally to localize the avulsion (Fig 3).

Before anchor placement and suture retrieval can be performed, the sciatic nerve must be identified and protected. The posterior femoral cutaneous nerve is typically encountered first as it is just lateral and posterior to the lateral border of the ischium. The sciatic nerve, which is deeper and lateral relative to the posterior femoral cutaneous nerve (Fig 4), can be explored using blunt dissection. The authors' preference is to use the non-toothed shaver to dissect to the sciatic nerve to avoid inadvertent injury or bleeding from nearby vascular structures.[11]

After developing the plane between the hamstring and gluteus maximus, the RFA is used to clear off any soft tissue on the ischium. Next, a 5.5-mm cylindrical burr (Stryker Endoscopy, San Jose, CA) is used to decorticate the footprint to create a bleeding bed of bone, as well as augment the biologic healing response.

Hamstring Repair

After punching and tapping, a triple-loaded 5.5-mm Peek AlphaVent anchor (Stryker Sports Medicine, Greenwood, CO) is placed at the footprint through a percutaneous portal using a spinal needle (Fig 5). All 6

Fig 1. (Top) Prone positioning of the surgical limb with extension of the hip and flexion of the knee, relaxing both the gluteus maximus muscle, as well as the sciatic nerve. Relevant landmarks (ischial tuberosity and gluteal crease) can be palpated and drawn out prior to incision. (Bottom) Placement of the medial portal (medial to the lateral border of the tuberosity, and ∼2 cm distal to the distal border) and the lateral border (3 to 4 cm lateral to the medial portal) both along the gluteal crease.

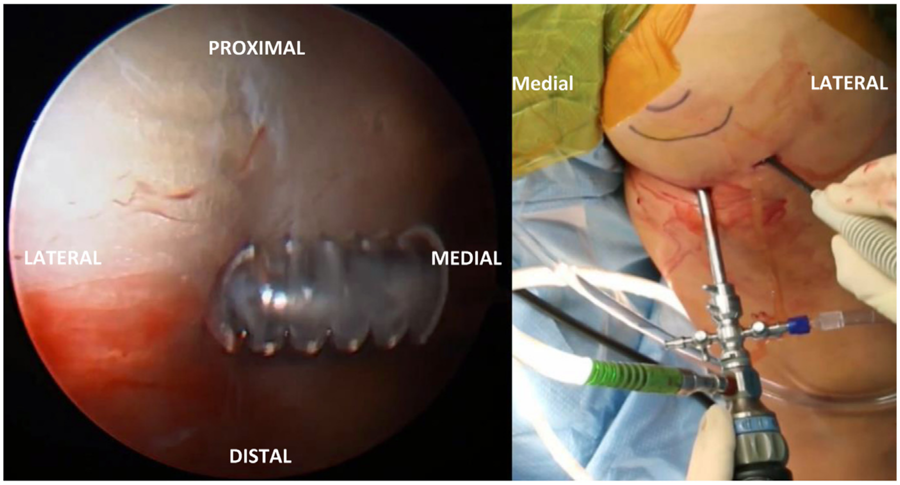

Fig 2. (Left) Arthroscopic ischial bursectomy and clearing of the subgluteal space to improve visualization prior to identifying the proximal hamstring defect. Thorough bursectomy allows for improved visualization and working space when identifying and repairing the hamstring tear. (Right) Patient is placed in the prone position, and the bursectomy is performed through the lateral arthroscopic portal and viewed via the arthroscope through the medial portal.

suture limbs are initially pulled out of the percutaneous portal for suture management.

An 8.0 × 90 mm cannula is placed through the lateral portal, and a tissue penetrator is passed from lateral to medial through the tendon stump. This trajectory aims away from the sciatic nerve, and, therefore, is safer than a medial to lateral direction (Fig 6). The passing suture is used to shuttle the first limb from the anchor through the tendon. This step is repeated for the matching limb of the suture, creating a horizontal mattress construct. This step is repeated until all 6 suture limbs are passed through the tendon stump. Ideally, there is about 0.5 cm of tendon between each limb of a single mattress, and 1 cm between each mattress (Fig 6).

Next, the arthroscope is switched to the lateral portal, and the tissue penetrating device is used to retrieve sutures from the medial aspect of the hamstring tear. The arthroscope is placed back into the medial portal, and the sutures are tied using alternating half hitches on alternating posts in a mattress configuration for anatomic hamstring repair (Fig 7).

Following repair, meticulous hemostasis is achieved to prevent hematoma formation, which could result in

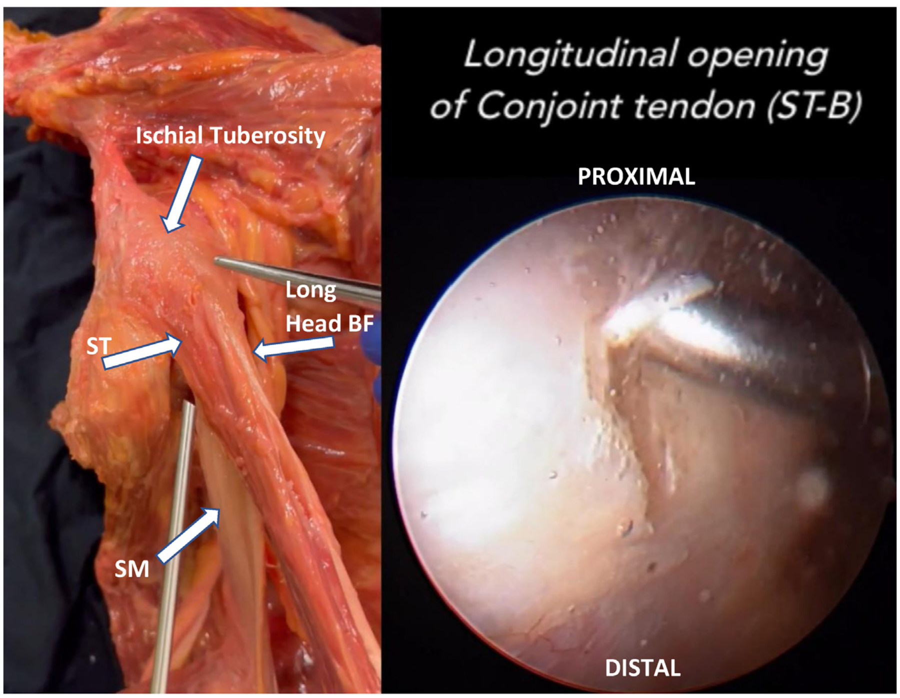

Fig 3. Anatomic (left) and arthroscopic (right) representation of longitudinal opening of the conjoint tendon (ST and long head BF) using a radio frequency ablater to localize the hamstring avulsion. Longitudinal opening is performed through the lateral portal, while camera visualization is performed through the medial portal. Palpation via the radiofrequency ablater or arthroscopic shaver can be used to identify the defect, as torn tissue will be softer and more ballotable than surrounding intact tissue. BF, biceps femoris; SM, semimembranosus; ST, semitendinosus.

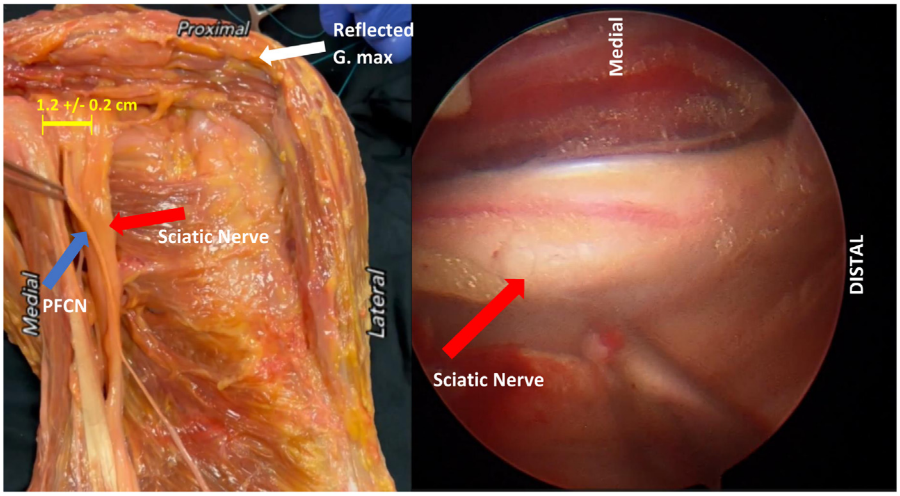

Fig 4. (Left) Anatomic dissection of the posterior femoral cutaneous nerve (PFCN) (blue arrow) and sciatic nerve (red arrow). The posterior femoral cutaneous nerve is encountered first, as it lies more medially, followed by the larger sciatic nerve, which is deeper and lateral to the posterior femoral cutaneous nerve. The sciatic nerve lies 1.2 ± 0.2 cm from the lateral aspect of the ischial tuberosity. (Right) Arthroscopic identification and releasement of the sciatic nerve is performed using an arthroscopic shaver in the lateral portal and viewed through the medial portal.

sciatic nerve compression. Additionally, the nerve is checked to ensure it is completely free, and not inadvertently tethered in the repair construct (Fig 7).

Discussion

The present technique article demonstrates an endoscopic approach to treat a partial proximal hamstring avulsion injury. The authors recommend the endoscopic approach for partial avulsion injures, those with minimal retraction (<2 cm), and injuries that have failed greater than 6 months of conservative treatment.

Endoscopic surgical repair of partial proximal hamstring avulsions has its inherent advantages and disadvantages, as outlined in Table 1. Additionally, salient pearls and pitfalls are outlined in Table 2. One of the primary advantages of the endoscopic approach is that it offers a minimally invasive technique, with smaller surgical incisions, lessening the risk of infection, wound complications, and bleeding. This is in contrast to the open approach, which has had previously had high complication rates reported postoperatively.[8] Additionally, the endoscopic view offers the surgeon with direct visualization of the posterior hip anatomy and hamstring defect, allowing the surgeon to perform more precise characterization of the tendon pathology and repair. Visualization of the ischial tuberosity can be comparatively challenging with an open approach, particularly in larger patients. Furthermore, throughout the procedure, there are multiple measures taken using direct visualization of the sciatic nerve to reduce the risk of iatrogenic nerve injury. Specifically, care must be taken with portal placement, particularly the lateral

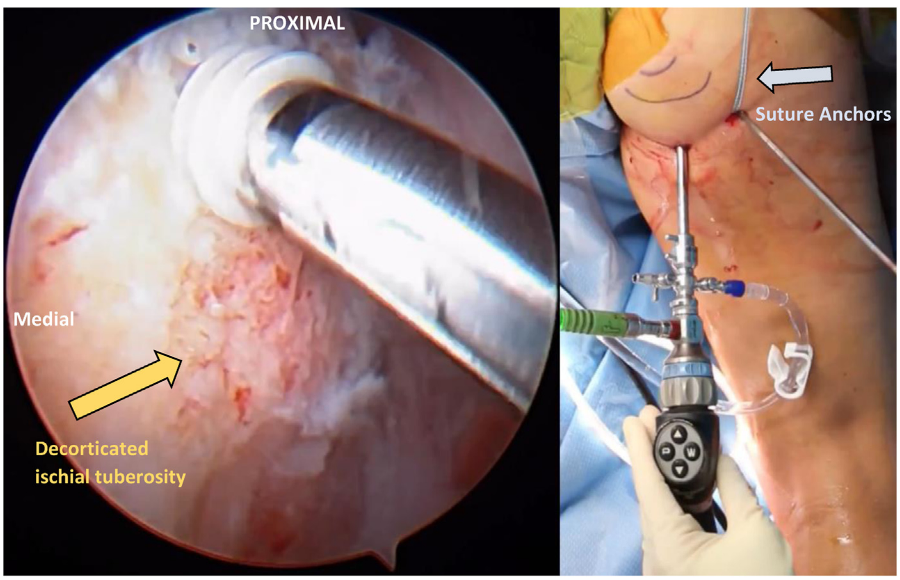

Fig 5. (Left) Arthroscopic placement of a triple-loaded 5.5-mm PEEK Alpha-Vent anchor into the decorticated ischial tuberosity (yellow arrow). Punch and tap typically precedes placement of the anchor. Anchor placement is performed through the lateral portal at the footprint of the proximal hamstring into the ischial tuberosity and viewed through the medial portal. (Right) Patient is placed in the prone position and, initially, all 6 suture limbs are pulled out of the percutaneous, lateral portal for suture management.

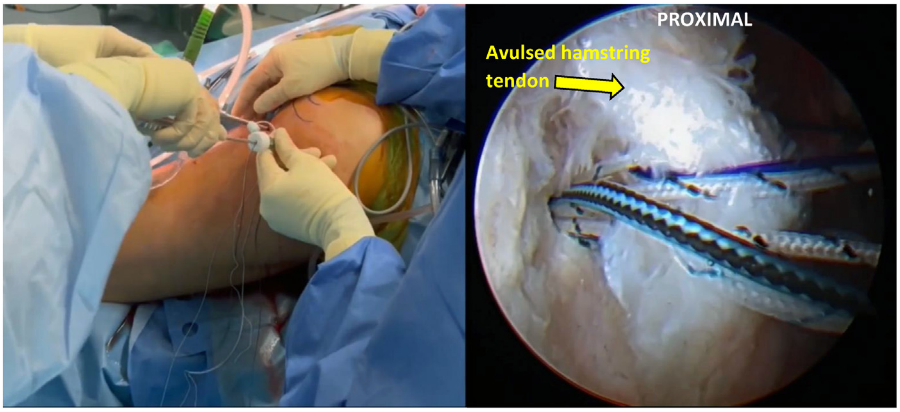

Fig 6. (Left) Passage of the sutures through the avulsed tenon is performed with the arthroscope in the medial portal, and the suture-penetrating device in the lateral portal. Sutures are passed from lateral to medial through the tendon, aiming away from the sciatic nerve to avoid iatrogenic injury. (Right) Arthroscopic image of suture passage lateral to medial through the tendon. A polydioxanone suture is used to shuttle the first limb of the suture through the tendon. This is repeated until all 6 suture limbs are passed. The camera is then switched to the lateral portal, and the suture limbs are grabbed from the medial side of the tendon. Of note, the arthroscopic image is in the coronal plane, with more prominent sutures being on the medial side of the tendon.

portal, as well as with suture limb passage to avoid neurovascular injury.

There are relevant disadvantages and pitfalls, outlined in Tables 1 and 2. First, as previously mentioned, the authors recommend the endoscopic approach for partial avulsions and those with minimal retraction. Chronic injuries with greater amount of retraction or more severe sciatic nerve adhesion may not be amenable to the endoscopic approach to begin with, or may require conversion to an open repair. Second, the technical challenge required to perform the procedure and to prevent iatrogenic nerve injury should not be underestimated. There may be longer operative times and increased risk of both intraoperative and postoperative complications.

Although limited, favorable outcomes have been reported following endoscopic repair. In a study of 12 patients at mean follow-up of 25 months, favorable outcomes were demonstrated, with all patients reporting visual analog scale (VAS) for pain scores of zero, as well as all patients returning to their original level activity at an average time of 6.5 months.[12] Additionally, no complications were noted within this cohort. In another endoscopic hamstring repair study, the outcomes of 20 patients at mean follow-up of 23 months demonstrated significant patient-reported outcome

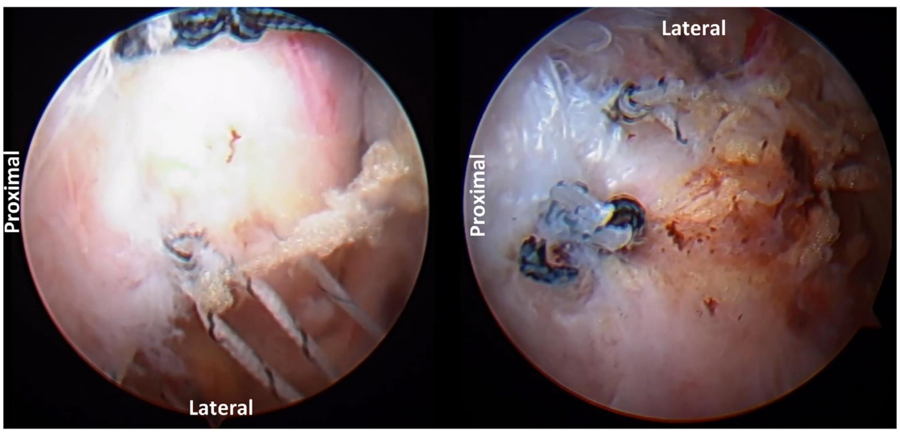

Fig 7. (Left) Once all suture limbs are passed through the tendon stump and retrieved, the sutures are tied in a single-mattress configuration with 1 cm between each mattress and 0.5 cm of tendon between each limb, using alternating half hitches on alternating posts. The knots are tied using a arthroscopic knot pusher via the medial portal, while the arthroscope is placed in the lateral portal. (Right) Final mattress configuration hamstring construct after meticulous hemostasis was performed, ensuring no hematoma formation that could compress the sciatic nerve. The arthroscope is placed in the medial portal to view from medially to laterally to ensure the sciatic nerve is not tethered in the final construct.

Table 1. Advantages and Disadvantages of Endoscopic Partial Proximal Hamstring Repair

Advantages	Disadvantages
• Minimally invasive, smaller surgical incisions decrease the risk of infection and wound complications. • Clearer visualization of tendon pathology, particularly partial tears • After medial portal is made, lateral portal is made under direct visualization, avoiding iatrogenic neurovascular injury. • Minimal blood loss • Patient positioned in the prone position with the knee partially flexed helps to avoid damage to the neurovascular structures. • Limits prolonged retraction of the gluteus maximus	• Difficulty with visualization and docking of chronic tears with extensive retraction • Steep learning curve. Surgeons need to be aware not to damage neurovascular structures during portal placement. • May take longer due to technical demand for the inexperienced surgeon

(PRO) improvements from preoperative to postoperative time points.[13] There were complications reported in this cohort with persistent hamstring weakness noted in 8 patients. The largest study examined 30 patients at an mean follow-up of 44 months, and reported 90% high satisfaction, 80% achievement of patient-acceptable symptomatic state (PASS), and 3% complications rate.[14] The study also reported 100% return to play in organized sport/return to work and 72.2% return to sport in recreational sports. The published articles demonstrated favorable outcomes at short-term follow-up; however, there are notable limitations, including small sample sizes, as well as differences in surgical indications and techniques.

Comparisons between the endoscopic and open approach are also limited, but there seems to be no notable differences in outcomes based on approach. Ryan et al.[15] published a biomechanical study in a cadaveric model between open and endoscopic techniques, citing no structural differences in terms of ultimate load, failure strain, and failure displacement.

Maldonaldo et al.[16] reported high average 2-year PROs among 50 patients treated with either the endoscopic or open approach. Bowman et al.[17] noted similar conclusions in 102 proximal hamstring repairs, with equivalent 1-year postoperative outcome scores, satisfaction, and complication rates between the 2 approaches. Of the limited articles published to date, surgical hamstring repair, regardless of approach, results in clinical outcome improvement, low rates of complications, and high rates of return to activity.

Table 2. Pearls and Pitfalls of Endoscopic Hamstring Repair

Pearls	Pitfalls
• Patient should be placed in the prone positions with all bony prominences padded and the knee is 45° of flexion. • Pump pressure should be set between 30 and 40 mm Hg with continuous outflow to avoid the risk of fluid extravasation, soft-tissue swelling, and compartment syndrome, while maintaining good visualization. • The medial portal should be made first, while the lateral portal should be made under direct visualization due to the close proximity to the sciatic nerve • Performing a thorough ischial bursectomy and clearing the subgluteal space allows for better visualization to increase working space. • While performing the bursectomy, viewing from lateral to medial provides better perspective of the hamstring defect and sciatic nerve. • Arthroscopic shaver should be used to identify, expose, and protect the sciatic nerve before any sutures are passed through the tendon. • The partial tear defect can be identified, as it is more ballotable compared to intact tendon. • Punching and tapping are typically required prior to anchor placement due to the bony strength of the ischial tuberosity. • Sutures are passed through the tendon from lateral to medial to avoid injury to the sciatic nerve. • Careful hemostasis should be ensured to prevent hematoma formation compressing the nerve, and the sciatic nerve should be reevaluated to ensure it is free.	• Chronic tears with extensive retraction may not be amenable to repair via the endoscopic approach. • Chronic injury cases may present with more tethering and adhesions of the neurovasculature, making the dissection more challenging. • Failure to identify and/or protect the sciatic nerve during any portion of the procedure can lead to severe neurologic injury. • Failing to maintain proper suture management during suture passage and knot tying may lead to prolonged time in the operating room.

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