Technical Note

Endoscopic Repair of Proximal Hamstring Insertion With Sciatic Nerve Neurolysis

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Abstract: Open surgical repair of proximal hamstring avulsions has been the standard of care for a long time, when surgery is needed. Endoscopic repair is a relatively new surgery, and its popularity increased in the last 10 years. This technique allows the surgeon an anatomic repair and a safe sciatic nerve exploration with small incisions and dissection. As a new technique, it has its limitations, mostly in chronic retracted tears, and long follow-up series are needed to assess long-term outcomes. We present an endoscopic repair of a right proximal hamstring avulsion performed along with a sciatic nerve neurolysis.

Proximal hamstring injuries are common among the young active population.[1] A prompt and appropriate diagnosis is needed, since these injuries may produce disability, chronic pain, and long rehabilitation periods before patients can return to sports.[1-3]

Hamstring injuries are common, comprising almost 29% of lower-extremity injuries in athletes.[1,4,5] Most of these injuries are muscle strains of the myotendinous junction.[1] Proximal injuries such as avulsion or avulsion fractures are rare,[6] but these injuries often require surgical fixation.[7,8]

Sports related to proximal hamstring injury mechanism are skiing, dancing, sprinting, and those that require explosive acceleration, as well as sports that combine this with kicking, like soccer.[1,6] All the aforementioned activities require hip flexion with the following hamstring eccentric contraction and injury.[1,2,6]

The hamstring complex is a muscle group that encompasses 3 muscles, the biceps femoris, the semitendinosus, and the semimembranosus.[1,6,7,9] These 3 muscles have a common tendinous origin in the ischial tuberosity, except for the short head of the biceps femoris.[1,9] All of them have distinct distal insertions below the knee.[1,6,9] The complex works as a hip extensor and knee flexor.[6]

The hamstring footprint on the ischial tuberosity has an oval shape and 2 independent insertion sites.[6,10] The semimembranosus has a curved and lateral insertion.[6,9,11] Meanwhile, a conjoined tendon of the semitendinosus and long head biceps femoris has an insertion site that is medial, superior, and superficial to the semimembranosus insertion.[2,6,10,11]

Proximal injuries can be divided as complete avulsion, complete apophyseal fracture avulsion, partial avulsion, and degenerative partial avulsions.[12] The presentation may not be typical and should be differentiated from proximal myotendinous junction strains. Magnetic resonance imaging is the gold standard for diagnosis.[12,13]

Surgical Technique (With Video Illustration)

Preoperative Assessment

A thorough preoperative evaluation is made before booking the case. A complete physical examination and imaging evaluation is essential. The tear patter, retraction, and sciatic nerve–related symptoms must be

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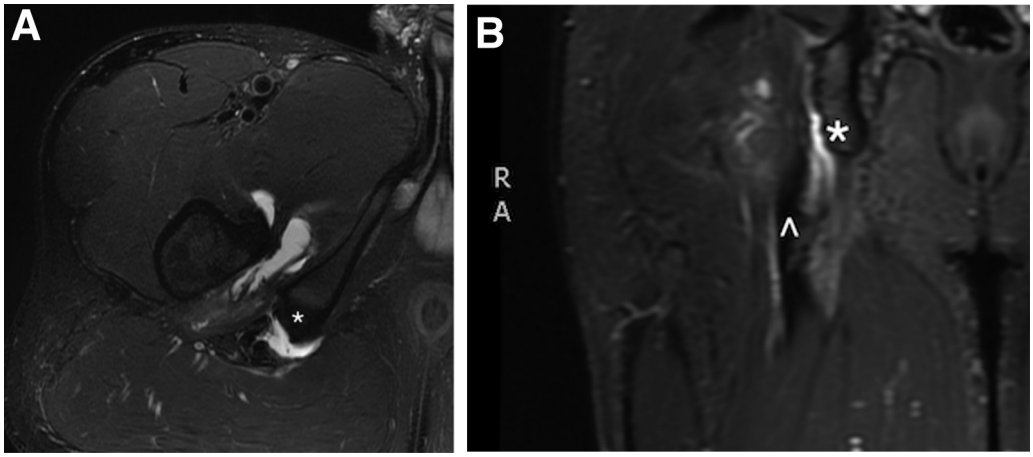

Fig 1. Magnetic resonance imaging (MRI) multiplane reconstruction images showing the full-thickness, 3-tendons minimally retracted hamstring avulsion. (A) Axial reconstruction MRI showing the right hemipelvis and right proximal femur. At this level, the hamstring footprint (*) is appreciated; in regular conditions, no inflammatory fluid is seen in the area and the tendons are attached to the ischium. (B) Coronal reconstruction MRI of the right hemipelvis and right proximal femur. This image shows in another plane the bare footprint (*) with the minimally retracted tendon (^) distal to it. Increased signal of inflammatory fluid between these structures is clearly visible.

taken in consideration. The case presented here had a full-thickness, 3-tendon avulsion, as seen in Figure 1. Pearls and pitfalls of endoscopic repair are listed in Table 1.

Anesthesia and Patient Positioning

General anesthesia and antibiotic prophylaxis are administered. The patient is positioned prone on the operating room table, assuring that the hip and knee can be mobilized through the case as seen in Video 1. All bony prominences are protected. Sterile preparation and drape including ipsilateral buttock and lower extremity are done. Room setup and patient positioning can be visualized in Figure 2.

Endoscopic Evaluation

The ischium landmark is outlined on the skin and the central portal is created on the gluteal fold in line with the ischium, as seen on Figure 3A. Fluoroscopic guidance is used to guide the blunt trocar towards the ischium, to protect the sciatic nerve, which lies approximately 1 to 2 cm lateral to the hamstring origin on the ischium.[14] The lateral portal is created with aid of a spinal needle and direct visualization. A bursectomy with an arthroscopic shaver is made to clear the underlying structures, and a diagnostic endoscopic evaluation is performed, identifying the ischial tuberosity, remaining tendon fibers, and sciatic nerve, as seen in Video 1.

Table 1. Pearls and Pitfalls of the Technique

Pearls	Pitfalls
Patient positioning and prep are critical. The surgeon should be able to work with slight hip abduction, and he or she also should be able to flex and extend the knee.	Prone position. Adequate padding of potential pressure points should be granted, these cases can be long. The anesthetist must have no concerns with ventilation.
Use C-arm, especially if you are not familiar with the endoscopic anatomy of the region. This is a challenging surgery, and all measures should be used to avoid nerve injury.	Chronic retracted tears. These tears are a surgical challenge. The surgeon must know their own technical limitations as well as the techniques limitations.
Anchors. Biomechanical studies have shown high resistance to cyclic loads with many anchor types and locations. We recommend using at least two.	Tendon identification. For unexperienced surgeons, this could be challenging, mostly in partial tears.
Be familiar with the open approach in case you need to open.	Nerve dissection. Sciatic nerve must be identified. Sometimes the posterior cutaneous nerve comes into the field, it should also be protected.

Fig 2. Clinical picture of the room setup and patient positioning. The patient is positioned prone in a regular operating table; special care is taken to protect bony prominences and neurovascular structures. When draping, it is recommended to have the whole leg in the surgical field, allowing for mobilization of both hip and knee, which helps to reduce or increase tension in the tendons as needed, as well as abducting the leg to protect the sciatic nerve. Endoscopic instruments are placed on a mayo table accessible for the surgeon and assistant, availability of complete hip instruments, 30° and 70° scopes is recommended. Also, an adequate and ergonomic position of the arthroscope and C-arm monitors are required.

Sciatic Nerve Identification and Neurolysis

As discussed previously, the distance of the sciatic nerve from the area of repair is minimal, which is why identification of the nerve is critical. The amount of scarring varies in every patient but usually has a direct relationship with time after the injury. In this case, the nerve was surrounded by scar tissue, as shown in Video 1. Blunt dissection of the area lateral to the ischial tuberosity is done until identification of the sciatic nerve. If the patient has symptoms related to nerve compression, neurolysis should be performed.[15] As seen in Figure 4, pre- (Fig 4A) and post- (Fig 4B) neurolysis endoscopic views are seen.

Footprint Identification and Preparation

A longitudinal split of the hamstring sheath is made with a Samurai Blade (Stryker, Kalamazoo, MI; Fig 4A), and the bare footprint on the ischium is appreciated (Fig 4B). The footprint is debrided, scar tissue and periosteum are cleared with a coblation device Werewolf (Smith & Nephew, Andover, MA), and an arthroscopic burr is used to obtain a healthy bleeding bone bed (Fig 4C).

Anchor Insertion and Tendon Repair

Additional portals can be created according to the ideal anchor location and suture manipulation. On regular basis, a medial portal and an accessory portal are created with the same technique as the lateral one with direct visualization, as seen in Figure 3B. It's important to keep in mind that the posterior femoral cutaneous nerve divides just above the ischial tuberosity, and the inferior gluteal nerve and artery travel 5 cm proximal to the ischium.[14] The number of anchors is determined according to the tear pattern; fewer than

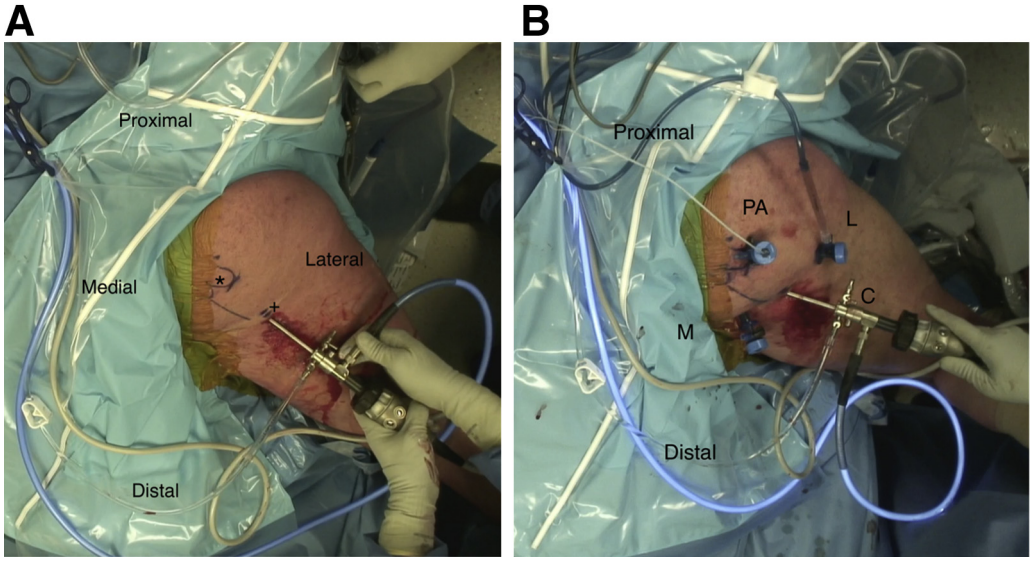

Fig 3. Clinical pictures of the skin landmarks and the four portals that are regularly used for this repair. (A) After the ischium is palpated and outlined on the skin (*), the procedure begins establishing the central portal (+) in line with the gluteal fold. (B) Outside view of the surgical area showing the portals used for the procedure, medial (M), central (C), and lateral (L) in line with the gluteal fold, and the proximal accessory portal (PA) that is located directly over the ischium. This PA portal is used mainly for suture management. Using cannulas is recommended.

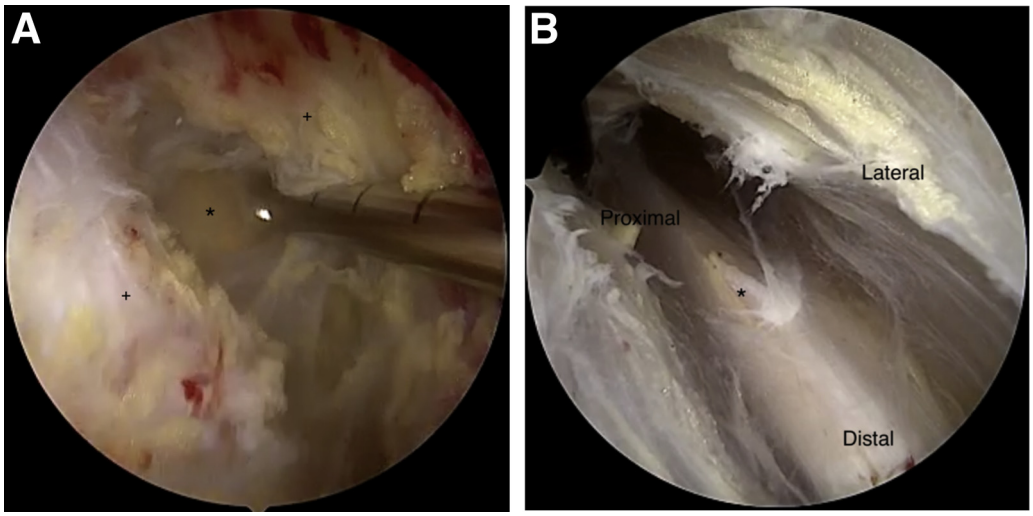

Fig 4. Sciatic nerve identification and neurolysis. (A) With the camera in the central portal, and the working tools coming from the lateral portal, a thorough assessment of the area is performed. First palpation with a probe gives a general idea of the anatomic structures. Once identified, blunt dissection to perform the neurolysis is recommended to decrease the risk of injury. A continuous layer of scar tissue covering the sciatic nerve was present in this case. The first look of the sciatic nerve (*) was obtained buried in the thick layer of scar tissue (+). (B) With the camera in the central portal, the final view of the sciatic nerve (*) is observed. The nerve can be followed both proximally and distally confirming it is not trapped in scar tissue.

2 anchors are not recommended. For this case, two 5.5-mm triple-loaded HEALICOIL anchors (Smith & Nephew) were introduced, using its awl and tap. The suture limbs are shuttled through the tissue with a FIRSTPASS (Smith & Nephew). One limb of each suture was shuttled from bottom to top through conjoined tendon and the other limb through the semimembranosus tendon, detailed in Video 1. We recommend shuttling all the sutures before tying the knots (Fig 5 D-E) SMC knots are tied from proximal to distal, and horizontal mattress configuration is achieved with an anatomic reinsertion of both tendons (Fig 5F).

Closure

A final assessment is performed visualizing the repair and the natural excursion of the sciatic nerve. The inflow solution is used for irrigation to clear any debris, the portals are closed with skin staples.

Rehabilitation

The patient is instructed to wear a brace to protect hip flexion, up to 40°. Toe touch is initiated after 2 weeks and progresses to full weight-bearing at 6 weeks. Passive range of motion is allowed since the beginning, without extreme tension on the repair with hip flexion and knee extension in the first 6 weeks. Between weeks 6 and 10, isotonic strengthening can begin with a maximal hip flexion of 100°.[7]

Discussion

Proximal hamstring surgical repairs have been mentioned in the literature since 1988.[6,16] The surgery has proven to be effective, achieving good patient satisfaction, pain relief, and strength improvement.[17,18] Early surgery has been linked with better results and a faster return to sports.[8,17]

Specific surgical indications have been established to surgically repair these tears.[6,76,7] The literature recommends surgical repair when 2 or more tendons are involved, a complete tear with 2 cm of retraction, and in patients who have not responded to 3 to 6 months of conservative management.[1,6]

Endoscopic repair has gained popularity in the last 10 years, with good outcomes.[19-22] Even though it has its limitations and is a technically demanding surgery, open surgery is still needed for severely retracted complete tears.[6,23] Even in the setting of a chronic tears, endoscopic techniques with graft augmentation have been described.[24,25] When indicated, earlier surgical repair has proven better outcomes than delayed repair.

Multiple complications have been reported in open and endoscopic surgeries. Sciatic and posterior femoral cutaneous nerve traction injuries are the most common neurologic injuries.[1] Weakness is a frequently reported complication, Kurowicki et al.[21] report a high incidence of subjective hamstring weakness in 42.1% of a small

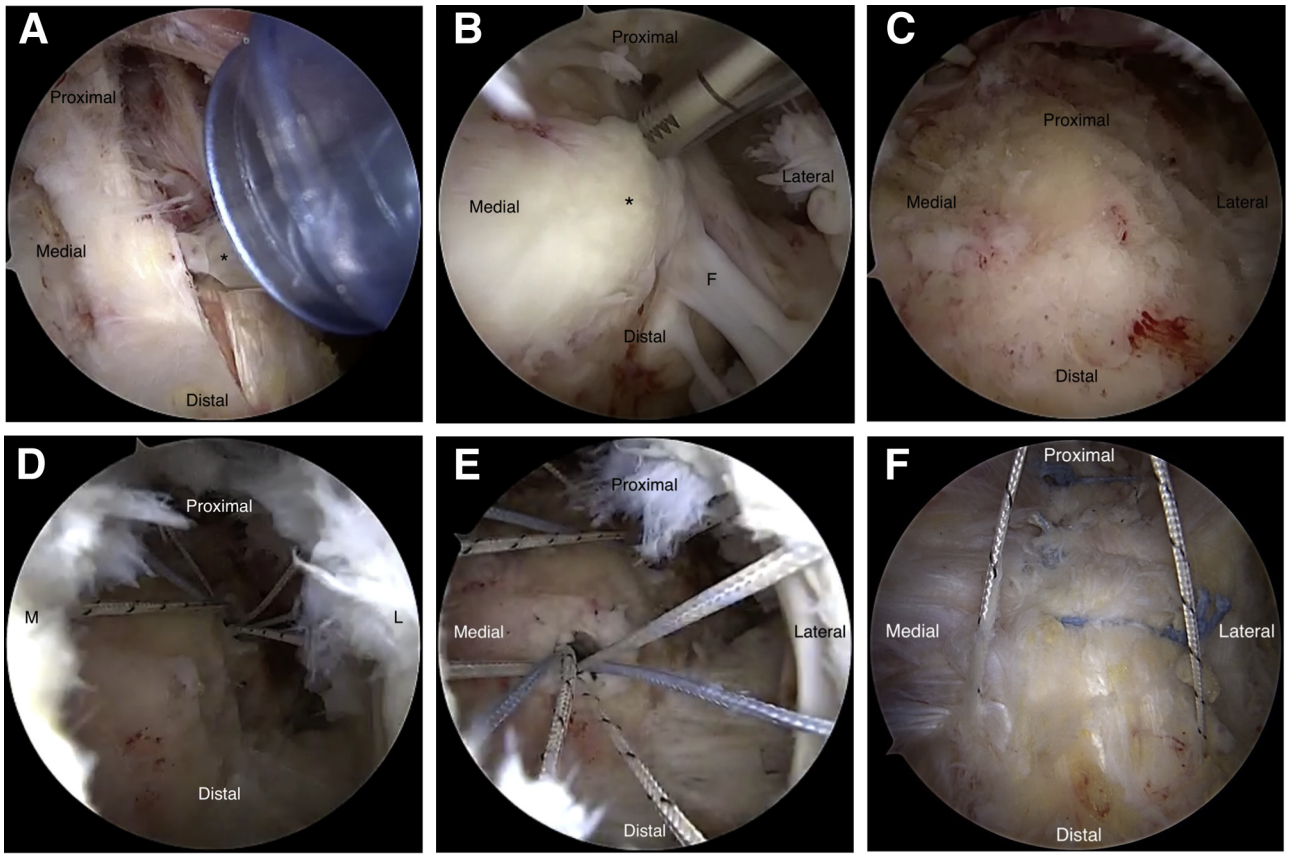

Fig 5. Tendon repair. (A) Arthroscopic view of the subgluteal space showing a samurai blade (*) splitting the tendon sheath in line with its fibers to expose the footprint. The camera is in the central portal and the blade is entering through the lateral portal. (B) Moving the camera to the lateral portal, a direct view of the bare footprint (*) is seen. Instruments can be used from the central portal to assess the area. In this case, a few remnant fibers (F) were identified and preserved. A combination of arthroscopic shaver, coblation device, and burr is used to debride the anatomic footprint to improve healing potential of the repaired tendons. (C) Moving the camera to the central portal again, the debrided and decorticated footprint shows a healthy bleeding bone bed. (D) Keeping the camera in the central portal, a full view of the footprint is used to plan the anchor placement. Bone in this area is dense, using a drill and tap is highly recommended if threated anchors are used. The first triple-loaded anchor was placed proximal and lateral in the footprint. Medial (M) and lateral (L) portals are used to shuttle the sutures to both sides of the tear. (E) With the camera in the central portal, the second anchor is placed more distal and medial to the first one, and sutures are shuttled through both sides of the tear as performed for the previous anchor using medial and lateral portals. (F) With the camera in the central portal, sutures are retrieved in pairs from the proximal accessory portal and are tied from proximal to distal using sliding knots and secured with 3 half hitches.

Table 2. Advantages and Disadvantages of the Technique

Advantages	Disadvantages
Less invasive than a regular open repair without compromising the view or overall exposure.	This technique has a steep learning curve.
The literature has shown an overall return to sports after hamstring repair of around 94%.	Technically demanding, is an area not familiar to many orthopaedic surgeons. The technique requires certain ability of suture management.
	Complications have been reported for the technique. From patients subjective feeling of weakness, or pain sitting, to retear.

cohort series after endoscopic report.[21] Reports of open repairs show good-to-excellent subjective results in 95% of the patients.[1] Good quality and longer follow-up studies are still needed since the actual recommendations have a grade of evidence B and C.[7,21] Advantages and disadvantages of endoscopic repair are listed in Table 2.

References

1. Ahmad CS, Redler LH, Ciccotti MG, Maffulli N, Longo UG, Bradley J. Evaluation and management of hamstring injuries. *Am J Sports Med* 2013;41:2933-2947. https://doi.org/10.1177/0363546513487063.
2. Hamming MG, Philippon MJ, Rasmussen MT, et al. Structural properties of the intact proximal hamstring origin and evaluation of varying avulsion repair techniques: An in vitro biomechanical analysis. *Am J Sports Med* 2015;43:721-728. https://doi.org/10.1177/0363546514560878.
3. Domb BG, Linder D, Sharp KG, Sadik A, Gerhardt MB. Endoscopic repair of proximal hamstring avulsion. *Arthrosc Tech* 2013;2:e35-e39. https://doi.org/10.1016/j.eats.2012.10.003.
4. Brooks JHM, Fuller CW, Kemp SPT, Reddin DB. Incidence, risk, and prevention of hamstring muscle injuries in professional rugby union. *Am J Sports Med* 2006;34:1297-1306. https://doi.org/10.1177/0363546505286022.
5. Woods C, Hawkins RD, Maltby S, Hulse M, Thomas A, Hodson A. The Football Association Medical Research Programme: An audit of injuries in professional football—Analysis of hamstring injuries. *Br J Sports Med* 2004;38:36-41. https://doi.org/10.1136/bjsm.2002.002352.
6. Bertiche P, Mohtadi N, Chan D, Hölmich P. Proximal hamstring tendon avulsion: State of the art. *J ISAKOS* 2021;6:237-246. https://doi.org/10.1136/jisakos-2019-000420.
7. Heer ST, Callander JW, Kraeutler MJ, Mei-Dan O, Mulcahey MK. Hamstring injuries: Risk factors, treatment, and rehabilitation. *J Bone Joint Surg Am* 2019;101:843-853. https://doi.org/10.2106/JBJS.18.00261.
8. Coughlin RP, Kay J, Shanmugaraj A, Memon M, Naji L, Ayeni OR. Return to sport after surgical management of proximal hamstring avulsions: a systematic review and meta-analysis. *Clin J Sport Med* 2020;30:591-611. https://doi.org/10.1097/JSM.0000000000000688.
9. Stępień K, Śmigielski R, Mouton C, Ciszek B, Engelhardt M, Seil R. Anatomy of proximal attachment, course, and innervation of hamstring muscles: A pictorial essay. *Knee Surg Sports Traumatol Arthrosc* 2019;27:673-684. https://doi.org/10.1007/s00167-018-5265-z.
10. Feucht MJ, Plath JE, Seppel G, Hinterwimmer S, Imhoff AB, Brucker PU. Gross anatomical and dimensional characteristics of the proximal hamstring origin. *Knee Surg Sports Traumatol Arthrosc* 2015;23:2576-2582. https://doi.org/10.1007/s00167-014-3124-0.
11. Miller SL, Webb GR. The proximal origin of the hamstrings and surrounding anatomy encountered during repair. *J Bone Joint Surg Am* 2008;90:108-116. (suppl 2 part 1). https://doi.org/10.2106/JBJS.G.01281.
12. Fletcher AN, Lau BC, Mather RC. Endoscopic proximal hamstring tendon repair for nonretracted tears: An anatomic approach and repair technique. *Arthrosc Tech* 2020;9:e483-e491. https://doi.org/10.1016/j.eats.2019.11.022.
13. Koulouris G, Connell D. Evaluation of the hamstring muscle complex following acute injury. *Skelet Radiol* 2003;32:582-589. https://doi.org/10.1007/s00256-003-0674-5.
14. Ryan MK, Beason DP, Fleisig GS, Emblom BA. Portal placement and biomechanical performance of endoscopic proximal hamstring repair. *Am J Sports Med* 2019;47:2985-2992. https://doi.org/10.1177/0363546519866453.
15. Wilson TJ, Spinner RJ, Mohan R, Gibbs CM, Krych AJ. Sciatic nerve injury after proximal hamstring avulsion and repair. *Orthop J Sports Med* 2017;5:2325967117713685, 10.1177/2325967117713685.
16. Ishikawa K, Kai K, Mizuta H. Avulsion of the hamstring muscles from the ischial tuberosity. A report of two cases. *Clin Orthop Rel Res* 1988;(232). https://doi.org/10.1097/00003086-198807000-00019.
17. Belk JW, Kraeutler MJ, Mei-Dan O, Houck DA, McCarty EC, Mulcahey MK. Return to sport after proximal hamstring tendon repair: A systematic review. *Orthop J Sports Med* 2019;7:2325967119853218, 10.1177/2325967119853218.
18. Bodendorfer BM, Curley AJ, Kotler JA, et al. Outcomes after operative and nonoperative treatment of proximal hamstring avulsions: A systematic review and meta-analysis. *Am J Sports Med* 2018;46:2798-2808. https://doi.org/10.1177/0363546517732526.
19. Dierckman BD, Guanche CA. Endoscopic proximal hamstring repair and ischial bursectomy. *Arthrosc Tech* 2012;1:e201-e207. https://doi.org/10.1016/j.eats.2012.07.005.
20. Laskovski JR, Kahn AJ, Urchek RJ, Guanche CA. Endoscopic proximal hamstring repair and ischial bursectomy using modified portal placement and patient positioning. *Arthrosc Tech* 2018;7:e1071-e1078. https://doi.org/10.1016/j.eats.2018.07.001.
21. Kurowicki J, Novack TA, Simone ES, et al. Short-term outcomes following endoscopic proximal hamstring repair. *Arthroscopy* 2020;36:1301-1307. https://doi.org/10.1016/j.arthro.2019.11.126.
22. Mehta N, Alter T, Beck EC, et al. Endoscopic repair of proximal hamstring tear with double-row suture bridge construct. *Arthrosc Tech* 2019;8:e675-e678. https://doi.org/10.1016/j.eats.2019.02.013.
23. Grasso M, O'Neill C, Constantinescu D, Moatshe G, Vap A. Reconstruction of chronic proximal hamstring

tear: Description of a surgical technique. *Arthrosc Tech* 2021;10:e1307-e1313. https://doi.org/10.1016/j.eats.2021.01.028.

24. Leininger A, Duerr RA, Chauhan A, McGovern RP, Christoforetti JJ. Endoscopic-assisted anatomic reconstruction of chronic proximal hamstring avulsion with Achilles allograft. *Arthrosc Tech* 2020;9:e1133-e1139. https://doi.org/10.1016/j.eats.2020.04.011.
25. Hamula MJ, Cady A, Yousefzadeh K, Banffy M. Endoscopic implantation of bioinductive patch for chronic partial retearing after hamstring repair. *Arthrosc Tech* 2021;10:e311-e316. https://doi.org/10.1016/j.eats.2020.10.009.