



Chronic Ischial Avulsion Fracture Excision With Primary Proximal Hamstring Repair: A Technique

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Abstract: Ischial avulsion fractures classically occur in the pediatric population and are relatively uncommon. These injuries are treated conservatively; however, in cases where there is greater than 2 cm of displacement, surgical intervention is recommended. In some cases, displaced fractures are either misdiagnosed or proper treatment is neglected, and patients who transition into adulthood are left with chronic nonunions that can become a source of pain and disability. Here we present a surgical technique for a chronic ischial avulsion fracture nonunion that is excised, and the hamstring tendons are then primarily repaired to the ischium using suture anchors.

The hamstrings consist of three biarticular muscles (semitendinosus, semimembranosus and the long head of the biceps femoris) that have a proximal origin at the ischium and one monoarticular muscle (short head of the biceps femoris) that originates on the femur. These muscles are innervated by the tibial portion of the sciatic nerve.¹ The semimembranosus muscle originates more laterally on the ischium, and the long head of the biceps femoris and semitendinosus form the conjoint tendon, which originates more medially on the ischium.¹ The short head of the biceps femoris originates on the linea aspera and in the supracondylar ridge of the femur and is innervated by the common fibular branch of the sciatic nerve.¹ Distally, the muscles insert on the tibia at the pes anserine and posteromedial tibia (semitendinosus and semimembranosus respectively)

and fibula (long head and short head of the biceps femoris).¹ These muscles help provide hip extension, pelvic stabilization, and knee flexion.¹

In athletes, hamstring injuries are one of the most common types of injuries and are reported at an incidence of 3 to 4.1/1000 hours of competition.^{1,2} Injuries can range from muscle strains to complete tendon ruptures and most commonly occur at the musculotendinous junction.¹ Of all hamstring injuries, proximal avulsion injuries are reported to be 12% of these, and 9% are complete avulsions.¹ These injuries are treated conservatively, with structured rehabilitation if they are less than 2 cm retracted or if only 1 tendon is involved. However, when 2 or more tendons are involved and greater than 2 cm of retraction is present, surgical intervention is recommended because of improved outcomes, return to activity, and patient satisfaction.^{3,4}

In the pediatric and adolescent population and rarely in the adult population, proximal hamstring injuries can present as ischial avulsion fractures. This is due to the stronger Sharpey's fibers that attach the muscle to the apophysis, which overpower the weaker apophyseal growth plate. Like adults with purely tendinous injuries, these injuries are typically treated conservatively; however, when there is more than 2 cm of displacement, surgical intervention is recommended.⁵ In acute injuries, surgical management typically consists of open reduction and internal fixation (ORIF) of the fracture. In some cases, these injuries can be misdiagnosed, which leads to a delay in care and subsequently the development of chronic nonunions.

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The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

Received April 11, 2022; accepted June 18, 2022.

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2212-6287/22491

<https://doi.org/10.1016/j.eats.2022.06.017>

These chronic nonunions can be very disabling for patients, often being symptomatic for many years. In some cases, these patients undergo extensive medical workups without resolution of symptoms. Surgical treatment for this problem is not well described and can include various techniques, most commonly ORIF.⁵⁻⁹ In this surgical technique, we describe resection of a chronic ischial avulsion fracture nonunion with primary repair of the proximal hamstring tendons.

Surgical Technique

Patient Evaluation, Imaging and Indications:

Patients' evaluation begins with a thorough history and physical examination. Classically, patients will report pain and discomfort to the posterior aspect of their proximal thigh, with or without radicular type neurologic symptoms. This pain originates from a prior traumatic event, in which they felt a pop at the posterior aspect of their proximal thigh. They seek medical attention but are ultimately treated conservatively. In many instances patients will have these symptoms for years, in which they describe pain and discomfort with activities and a sensation of "sitting on a rock." It is not uncommon for these patients to have seen multiple healthcare providers before their final referral.

On physical examination they can have a slight antalgic gait. The neurovascular examination typically is within normal limits; however, in some instances neurologic changes can be noted because of irritation of the sciatic nerve. Hip and knee range of motion, as well as motor strength, are noted, which can be decreased because of pain. Lastly, a palpable firm mass is often palpated at the proximal posterior thigh, which is often painful. Focused hamstring specific testing can be performed such as the reverse plank hold, which is usually positive.

Standard anteroposterior and frog-leg lateral x-ray films of the symptomatic hip are initially obtained, which can demonstrate a chronic large ischial avulsion fracture nonunion as seen in [Figure 1](#). Additionally, computed tomography and magnetic resonance imaging are performed to better appreciate the size of the nonunion as shown in [Figures 2](#) through [7](#).

In patients with chronic nonunion injuries, a trial of conservative management can be initiated that includes nonsteroidal anti-inflammatory drugs, injection therapy and physical therapy, and graduated progression of activities. Those in whom conservative management fails after 6 months are given an option of surgical intervention.

Surgical Technique

After general anesthesia and intubation, the patient is placed in the prone position with gel roll pads under the chest and abdomen, and all other bony prominences are well padded ([Fig 8](#)). A nonsterile U-drape is used to seal the surgical field. The surgical site is cleaned with both a chlorhexidine brush and 50/50 diluted hydrogen peroxide solution and then dried with a sterile towel. The leg is then prepped with ChlorPrep (BD Bioscience, Franklin Lakes, NJ) and draped in standard fashion, using a combination of sticky U-drapes and a stockinet over the lower leg with Coban (3M Corp, St. Paul, MN) wrap. The ischium is palpated at the level of the gluteal crease, and a transverse 8 to 10 cm site for incision is marked. The surgical site is then covered with Ioban (3M Corp, St. Paul, MN) ([Fig 9](#)).

A formal timeout is performed. A 10 blade is used to incise the skin. Senn rake retractors are used to provide tension on the tissues, and electrocautery is used to provide hemostasis and to reveal the underlying gluteal fascia ([Fig 10](#)). Larger rake retractors are then used to provide gentle tension on the soft tissues. The gluteal fascia is incised horizontally with Metzenbaum scissors

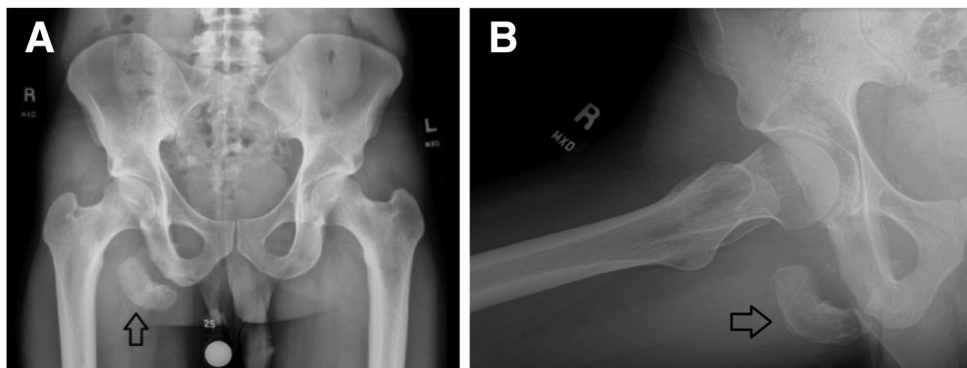


Fig 1. (A) Anterior-posterior pelvis X-ray of a patient demonstrating an ischial avulsion fracture on the right (*black arrow*). (B) A frog leg X-ray of the right hip demonstrating an ischial avulsion fracture (*arrow*).

Fig 2. Three-dimensional reconstruction computed tomography scan showing a fracture large nonunion of the right ischium.



both medially and laterally, revealing the gluteus maximus musculature. The inferior border of the gluteus maximus muscle is defined (Fig 11). A Schnitt is then used to enter below this muscle belly, and a Richardson retractor is placed under the gluteus maximus. Gentle finger dissection can be performed to further open this interval, palpating the native ischium and avulsion fracture piece. Care is taken to protect the cluneal, perineal, and descending branches of the posterior femoral cutaneous nerve (Fig 12).

Because of the chronicity, a sciatic nerve neurolysis is carefully performed by a microvascular surgeon, and a vessel loop is placed around this structure (Fig 13). This

provides mobility of this structure, and the vessel loop allows for easy identification during the remainder of the procedure.

Once the sciatic nerve is mobilized and protected, the ischial nonunion piece is exposed with a combination of Cobb elevators and electrocautery (Fig 14). Various clamps are used to assist in providing traction to help with mobilizing the bony nonunion piece.

Using electrocautery, the hamstrings tendons are removed from the fragment distally and tagged with traction sutures for later repair. Using clamps, very careful mobilization is performed to completely remove the bony nonunion piece (Fig 15). In this case, the piece

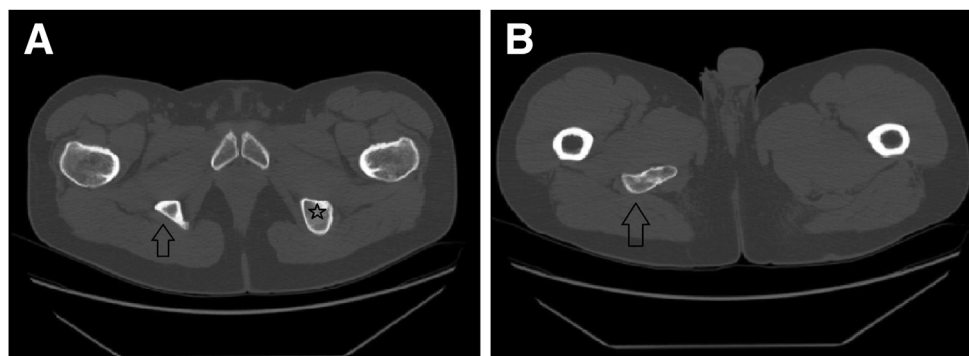


Fig 3. (A) With the patient in a supine position for the imaging, an axial computed tomography (CT) image at the level of the ischium showing evidence of a right native ischial tuberosity with bone loss (*black arrow*) and a normal left ischial tuberosity (*black star*). (B) With the patient in a supine position for the imaging, this is an axial CT image taken more caudal to part A, showing a large right-sided ischial tuberosity fracture nonunion from the right ischium (*black arrow*).

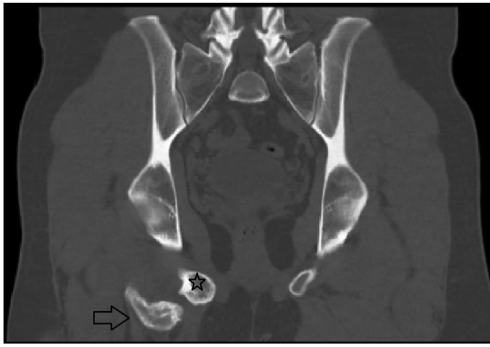


Fig 4. With the patient in a supine position for the imaging, a coronal computed tomography image at the level of the native ischium shows a large right-sided ischial tuberosity fracture nonunion (*black arrow*) and native ischium (*black star*).

measured 6×3.5 cm when placed on the back table (*Fig 16*). The detached hamstring tendons are tensioned to assess for any tendon contractures.

Attention is then turned to the ischium, which is eburnated because of the chronicity of the injury (*Fig 17*). Army navy retractors medially can be used to provide additional exposure. Using a combination of curettes and osteotomes, the ischial footprint is debrided to a bleeding surface.

Two 2.8 mm double-loaded Q-Fix (Smith and Nephew, Andover, MA) anchors are placed in the native ischium (*Fig 18*). The anchors are spaced on the ischium, with 1 more lateral and 1 more medial to



Fig 5. With the patient in a supine position for the imaging, a sagittal computed tomography image shows a large right-sided ischial tuberosity fracture nonunion (*black arrow*) and the native ischium (*black star*). Left of the image is anterior.

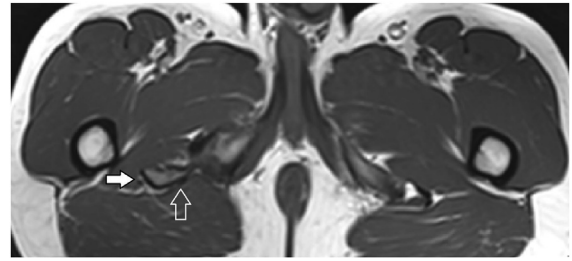


Fig 6. With the patient in a supine position for the imaging, an axial T1 magnetic resonance imaging scan at the level of the native ischium showing a right sided ischial tuberosity fracture nonunion (*white arrow*) and close association to the sciatic nerve (*solid white arrow*).

better recreate the normal anatomic footprints. The sutures from the anchors are then passed through the previously detached hamstring tendons in the following manner. The configuration of the stitches is that 1 limb of a pair becomes a locking stitch (with the other limb of the corresponding pair free) and then with the other pair, one limb is passed in a modified Mason-Allen stitch (with the other limb of the corresponding pair free) (*Fig 19*).

The lower leg is slightly flexed by an assistant, and the suture limbs that are free (not passed through the tendon) are pulled, using the anchor mechanism to reduce the tendon to the ischial footprint. The corresponding suture limb ends are then tied, and the reapproximated tendons are visualized (*Fig 20*).

The wound is copiously irrigated. The gluteal fascia is closed with interrupted 0-Vicryl. The remainder of closure is as follows: interrupted 2-0 Vicryl is placed in the deep subcutaneous tissues, interrupted 3-0 Monocryl is placed in the superficial subcutaneous tissues, and a running 4-0 Monocryl is placed in the

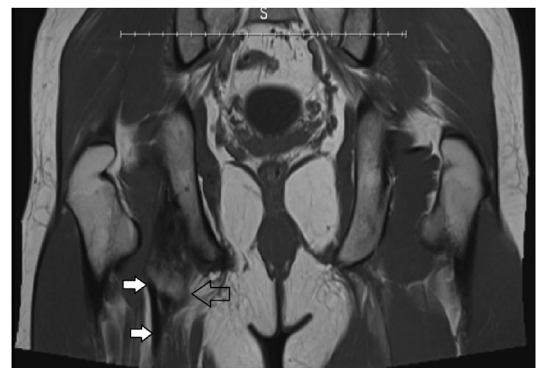


Fig 7. With the patient in a supine position for the imaging, a coronal T1 magnetic resonance imaging scan at the level of the native ischium showing a right sided ischial tuberosity fracture nonunion (*black arrow*) with intact hamstring tendons and origin site (*solid white arrows*).



Fig 8. An image showing a patient in the prone position, with chest roll pads to provide torso support and all other bony prominences padded with small gel pads and soft foam. Additionally, a pillow is placed under the feet.

subcutaneous skin. Dermabond is placed followed by a sterile Aquacel (ConvaTec, Princeton, NJ) dressing. The patient is rolled in a controlled manner to a stretcher and placed in a hip brace locked in neutral alignment.



Fig 9. An image showing a patient in the prone position, after sterile draping of the right lower extremity, the right ischium is palpated, and an 8 to 10 cm *horizontal line* is marked in the gluteal crease. Ioban is then placed over the skin.

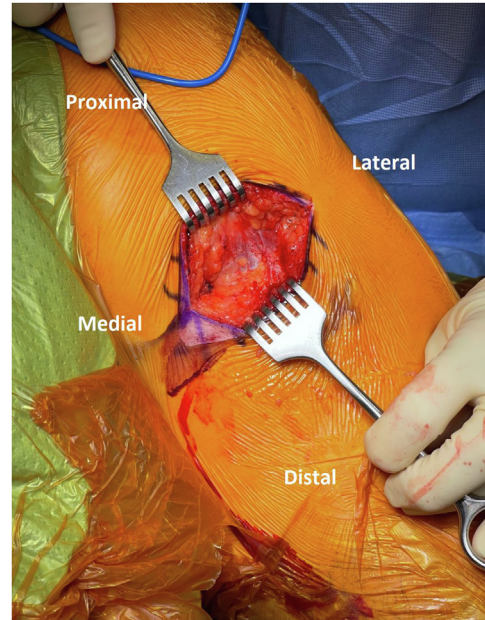


Fig 10. With the patient in the prone position, a skin incision is made over the right-side ischium in the gluteal crease and with gentle retraction and electrocautery the underlying gluteal fascia is revealed.

The patient is extubated and taken to the recovery room, and the patient is made flat foot partial weight-bearing in a hip brace that limits hip flexion, and they are started on chemical anticoagulation. An X-ray film of the pelvis is obtained at the first postoperative visit (Fig 21). A full video of the surgical technique can be found as supplementary data (Video 1). Pearls and pitfalls to this technique can be found in Table 1.

Discussion

The purpose of this article was to highlight the clinical presentation of a chronic ischial avulsion fracture and

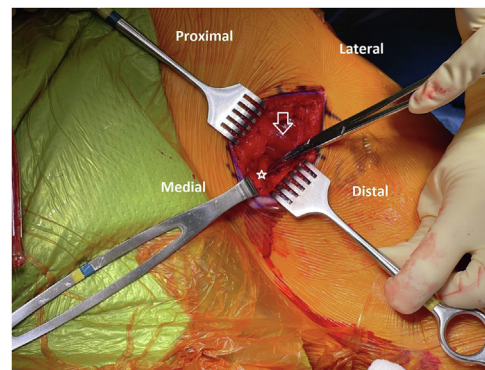


Fig 11. With the patient in the prone position, the right-sided gluteal fascia is opened with Metzenbaum scissors, and the inferior border of the right sided gluteus maximus muscle is visualized (*white arrow*), as well as the interval to the hamstring tendons (*white star*).

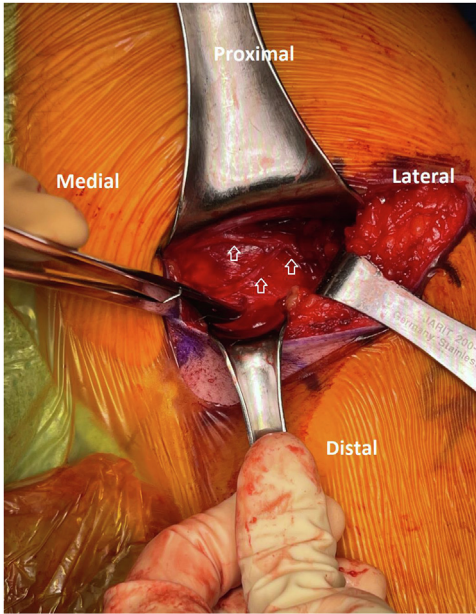


Fig 12. With the patient in the prone position, a Schnitz is used to enter inferior to the right-sided gluteus maximus muscle belly, and this interval it is gently opened. Further gentle blunt finger dissection can be carried down to the native ischium, and a Richardson retractor is placed, gently retracting the gluteal musculature cephalad. Here the cluneal, perineal and descending branches of the posterior femoral cutaneous nerve are visualized, and care is taken to protect these structures (*white arrows*).

outline the steps in our surgical technique for successful surgical intervention. Most ischial avulsion fractures are successfully treated conservatively, with 2 cm of

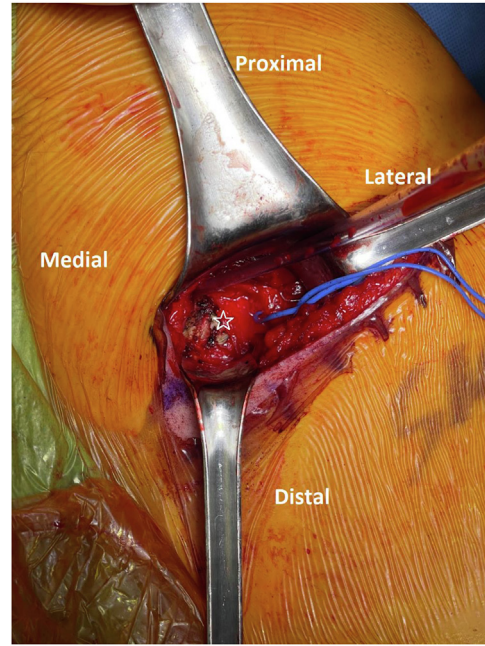


Fig 14. With the patient in the prone position, electrocautery is used, in combination with a Cobb elevator, to expose the right-sided ischial tuberosity fracture nonunion (*white star*).

displacement being the threshold for conservative versus surgical management.⁵ Patients with these injuries are commonly misdiagnosed, and subsequently there is a substantial delay in diagnosis.¹⁰ In some patients with displaced fractures, they develop chronic

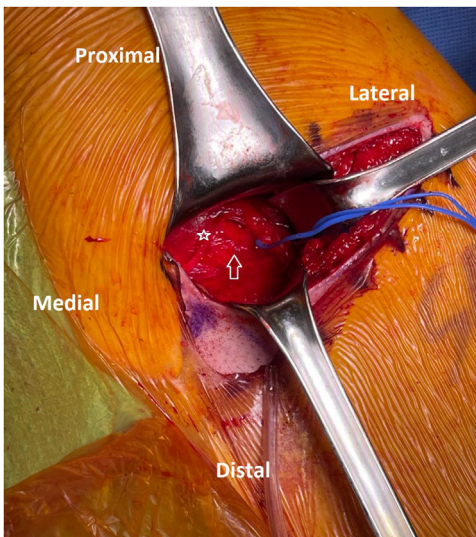


Fig 13. With the patient in the prone position, a right-sided sciatic neurolysis is performed, and a vessel loop is placed around the sciatic nerve. The right-sided ischial tuberosity fracture nonunion is identified (*white arrow*), and the perineal branch of the posterior femoral cutaneous nerve is identified (*white star*).

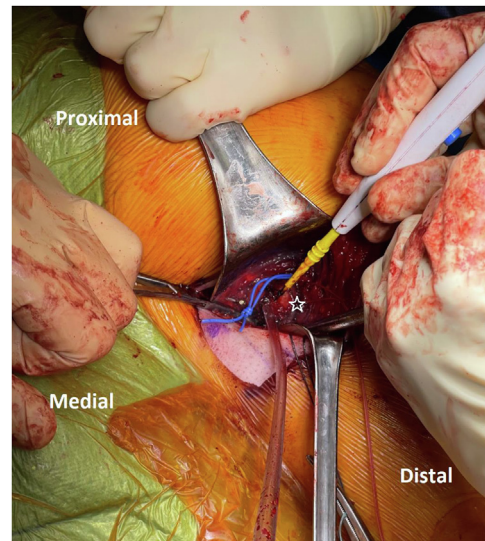


Fig 15. With the patient in the prone position, the right-sided hamstring tendons are tagged with braided suture and clamped with a hemostat. Various clamps are used to help provide traction to mobilize the ischial tuberosity fracture nonunion piece and electrocautery and Cobb elevators are used to fully free the piece (*white star*).

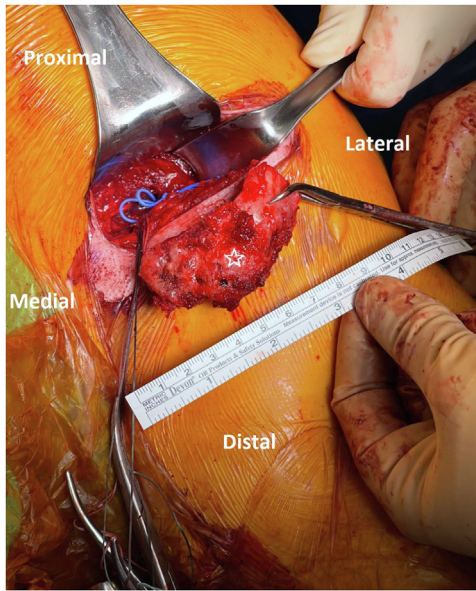


Fig 16. With the patient in the prone position, the right sided ischial tuberosity fracture nonunion piece is removed (*white star*), and a ruler is used to measure its size.

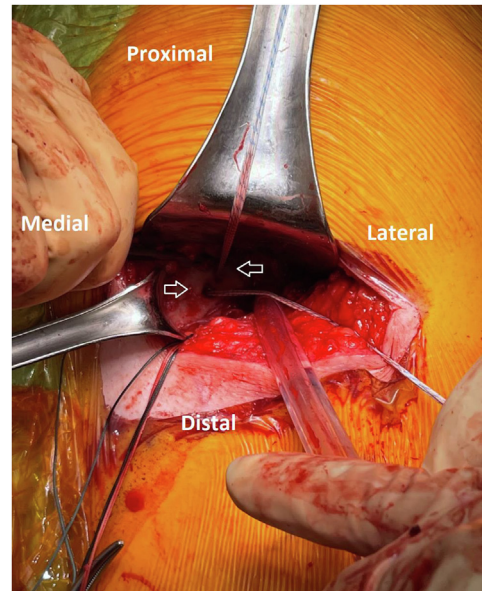


Fig 18. With the patient in the prone position, two 2.8 mm double loaded Q-Fix (Smith and Nephew, Andover, MA) anchors are placed in the right-sided native ischium (*white arrows*).

nonunions, which can be very symptomatic and can have a significant impact on their quality of life.

The first case of an ischial avulsion fracture was described by Berry in 1912.¹¹ Subsequently, there have been numerous case reports and case series describing this injury pattern.⁵ Surgical management for acute ischial avulsion fractures generally involves ORIF, with good reported outcomes.⁵⁻⁹

Surgical treatment for chronic avulsion fracture injuries is not well described in the literature and is limited to very few case reports and case series that include various techniques for fixation.^{6,12-15} The most common treatment method is performing an ORIF of the nonunion piece.^{6,13-15} Hughes et al.¹³ reported on a series of 2 patients who underwent ORIF with a posterior column screw and reported successful union

in both patients. In a series of 12 patients with various delays in presentation, Gidwani et al.¹⁰ described various techniques with ORIF or suture anchors and reported good to satisfactory results. Tetsunaga et al.¹⁶ reported using an all-suture technique that fixed the avulsion fracture to the ischium with excellent results. However, despite some reported success in the literature with fixation of the nonunion piece to the native ischium, there is concern that because of the chronicity of the fractures, performing an ORIF may result in a persistent nonunion. There are some proponents who

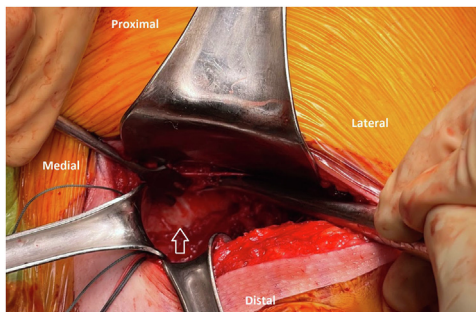


Fig 17. With the patient in the prone position, the native right-sided ischium is revealed showing a sclerotic and eburnated surface (*white arrow*).

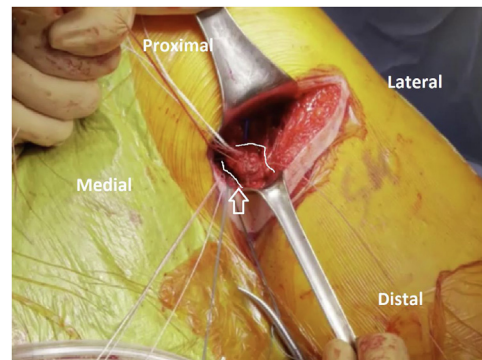


Fig 19. With the patient in the prone position, the right-sided hamstring tendon unit is shown here by the *white arrow* and the demarcated outline. The sutures from each anchor are passed through the right sided tendon. Each anchor has 2 pairs of sutures. One limb of a pair is passed in a locking fashion, and 1 limb of the other pair is passed in a Mason-Allen fashion. This will leave 2 free suture limbs. This process is repeated with the other anchor.

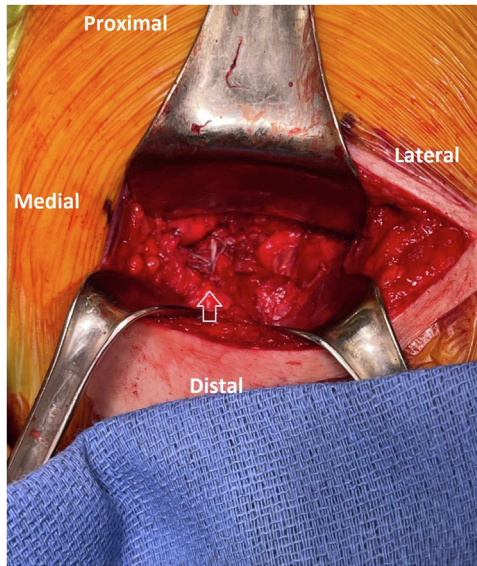


Fig 20. With the patient in the prone position, the free suture limbs from the anchor are pulled, delivering the tendon to the anchors, and the corresponding limbs are tied to one another, securing the hamstring tendon unit to the right sided ischium.

recommend bony resection of the symptomatic nonunion piece with or without primary repair of the hamstring tendons to the native ischium. Similar to our presented case, Dailey et al.¹² reported a case of a 10-year-old chronic ischial tuberosity avulsion fracture in a 27-year-old male treated with resection and primary tendon repair and reported excellent results at most recent follow-up.

In summary, although chronic ischial avulsion fractures are relatively rare, patients presenting typically have a delay in diagnosis, and this can have a significant effect on their quality of life. This technique article is useful for surgeons and practitioners to assist in diagnosing this debilitating condition, and our described



Fig 21. After surgery, an anteroposterior pelvis X-ray film is obtained in all patients on the first postoperative visit. This image demonstrates complete removal of a previous avulsion fracture nonunion of the right ischium, with evidence of suture anchor placement (*black arrow*).

Table 1. Pearls and Pitfalls of the Surgical Technique

Pearls

- Maintain adequate hemostasis during dissection.
- Using another surgeon with expertise in microsurgery to assist with sciatic neurolysis is beneficial.
- Be sure to place the anchors in a spread orientation both lateral and medial to help better recreate the native footprints.
- Gentle release of the hamstring tendon using a Cobb within the tendon sheath can be performed to provide additional excursion in chronic cases.
- After anchor placement, use hemostats to help identify the corresponding sutures for each anchor and to avoid confusion.
- Have an assistant slightly flex the lower extremity to approximately 45° when delivering the tendon to the footprint to help with tendon excursion.

Pitfalls

- During the superficial dissection, be mindful of inferior cluneal, perineal, and descending branches of the posterior femoral cutaneous nerve.
- Be cautious with aggressive gluteal retraction to avoid damaging the superior gluteal artery and nerve.
- Be mindful of the sciatic nerve during dissection and ischial preparation.
- Be wary of lateral retraction during the approach to avoid causing iatrogenic damage to the sciatic nerve.

technique is a safe, reproducible, and effective way to treat chronic ischial avulsion fractures.

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