Technical Note

Fixation of the Proximal Hamstring Tendon Using an All-Suture Tensionable Knotless Technique

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Abstract: Proximal hamstring injuries are a common sports and recreational injury among the active patient population. Surgical fixation of the tendons of the hamstring muscle complex, as opposed to conservative treatment alone, has shown improved patient outcomes, prompting the evolution of the suture anchors utilized in these repairs. Previous studies investigating the biomechanical properties of hamstring repair anchors have focused on double-row knotless techniques, in which the fixation of the overall construct relies on each individual anchor to maintain fixation. While these constructs have demonstrated biomechanical strength and clinical durability, each suture anchor represents a potential point of failure for the entire construct due to the crossed stitch anchor configuration. To address this limitation, recent tensionable knotless all-suture anchor designs have been implemented with success due to their smaller size and biomechanical strength. The aim of this technical note is, thus, to describe a technique for proximal hamstring repair using a tensionable knotless all-suture anchor construct that has 5 independent mattress sutures and, in doing so, employs the biomechanical strength of knotless fixation but eliminates the potential single point of failure seen with current knotless suture anchor designs.

Introduction

Proximal hamstring injuries are a common sports and recreational injury among active patients.[1] Typically, the injury occurs through forced hip flexion with combined ipsilateral knee extension, resulting in a forced eccentric contraction of the hamstring muscle complex.[2] The complex consists of 3 tendons: semimembranosus, semitendinosus, and biceps femoris, with the latter 2 tendons combing proximally to form the conjoint tendon. For patients with proximal hamstring avulsions, there has been considerable debate regarding appropriate management.[3] Traditionally, these injuries were mostly treated conservatively with generally favorable outcomes.[4] However, higher demand patients continued to complain of persistent cramping and weakness with conservative management.[2-4] Surgical treatment of the hamstring tendon is a promising alternative with studies demonstrating high rates of patient satisfaction and return to play.[5] Additionally, studies have shown improved outcomes with

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Fig 1. Patient is placed into the prone position. A padded roll is placed over the chest. All bony prominences are well padded. The bed is adjusted into a slight jack knife and Trendelenburg position.

surgical fixation, especially for 2 tendon tears with more than 2 cm of retraction, or injuries to all 3 tendons.[2,3,5-9]

Techniques for proximal hamstring repair have evolved significantly with both open and endoscopic techniques described.[7,10] Although the ideal approach is debated, the goal of repair is to achieve biomechanically equivalent strength to the native proximal hamstring tendon to allow for aggressive early rehabilitation. Suture anchors are the current gold standard for repair; however, most designs rely on knotted techniques, limiting the strength of the repair to the quality of the surgeon's knot-tying technique. Recently, knotless suture anchor designs have become more popular and may be biomechanically more favorable to traditional anchors.[11] Early knotless designs employed double-row techniques relying on interconnected sutures between anchors to achieve footprint compression and tensile strength. Although these constructs have demonstrated biomechanical strength and clinical durability, because of their interconnected suture configuration, each anchor represents a potential point of failure for the entire construct. This limits the overall strength of the construct to the pullout strength of the weakest suture anchor.

Recently, all-suture designs have grown in popularity. These anchors are smaller, allowing for a decreased distance between anchors and higher anchor density in the tendon footprint. Additionally, their size facilitates decreased bone loss during placement, and the biologically inert nature of the suture minimizes potential osteolysis or cyst formation over time. Biomechanical studies have confirmed that these anchors have superior strength to traditional metal suture anchors, and at least equivalency to modern PEEK and bioabsorbable designs.[12,13]

In this study, we describe a technique to repair the proximal hamstring with an all-suture anchor knotless construct that 1) uses 5 independent mattress sutures, 2) uses the biomechanical strength of knotless fixation, and 3) eliminates the potential single point of failure seen with current knotless suture anchor designs.

This study was performed in accordance with the ethical standards in the 1964 Declaration of Helsinki and was carried out in accordance with relevant regulations of the U.S. Health Insurance Portability and Accountability Act (or HIPAA). Details that might disclose the identity of the subjects under study have

Table 1. Pearls and Pitfalls of Proximal Hamstring Repair with Knotless All-Suture Anchors

Pearls	Pitfalls
General anesthesia with ET tube is recommended due to prone patient positioning.	Failure to incise and release the gluteal fascia laterally enough will prevent adequate visualization of the hamstring footprint.
Paralytics should be avoided to allow for monitoring of sciatic nerve activity.	In chronic cases, the sciatic nerve must be carefully dissected, as scar tissue may form between the proximal tendon and nerve.
During dissection, the gluteus maximus must be dissected off the distal gluteal fascia to allow for mobilization of the muscle belly and ensure adequate visualization.	Deep lateral retractor should be placed with care to avoid compression to neurovascular structures.
The gluteal fascia should be released laterally enough to allow for mobilization of the gluteus maximums muscle.	Placement of the anchors too distally and medially on the ischium may result in sitting pain postoperatively. Fluoroscopy should be used to confirm correct positioning of the anchors on the superior lateral border of the ischium.
For retracted tears, a large bump can be utilized to keep the knee bent and allow for adequate mobilization of the tendon.	
During the sciatic nerve neurolysis, an assistant should maintain his hand on the foot to monitor for nerve activity.	

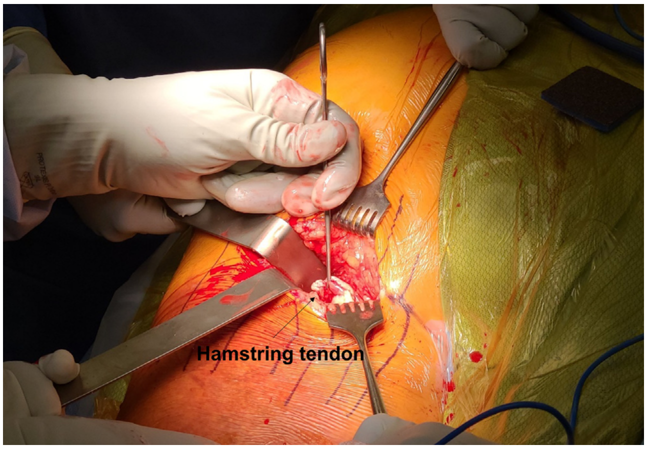

Fig 2. The proximal hamstring is isolated, and an Alice clamp is placed over tendon. A simple traction stitch is placed in the proximal tendon. A tenolysis is performed removing all fibrous attachments to the tendon and allowing for full excursion.

been omitted. This study was approved by the Institutional Review Board (IRB ID: 5276).

Surgical Technique (With Video Illustration)

Video 1 demonstrates the technique for all-suture knotless fixation of the proximal hamstring.

Patient positioning

After obtaining surgical consent, the correct limb is marked in the preop holding area and the patient is brought to the operating room. General anesthesia is induced on the patient's gurney, and then the patient is transferred onto the operating table in the prone position on padded chest rolls. All bony and soft tissue prominences are then padded. The bed is placed into a slight jackknife and Trendelenburg position. Two clear U-shaped nonsterile plastic drapes isolate the surgical field. The leg is then prepared with ChloraPrep (Becton Dickinson, Franklin Lakes, NJ) while two $^{3}/_{4}$ sheets are placed above and below the extremity. An impervious stockinette is placed over the foot and wrapped with a Coban (3M, St. Paul, MN). Two, large U-shaped drapes are then used to isolate the field. The gluteal crease is marked using a marking pen, and the exposed skin is covered with Ioban (3M Corporation) (Fig 1).

Surgical Approach

A roughly 8-cm incision is made in the gluteal crease over the previous skin mark, using a no. 10 blade. After hemostasis is obtained, dissection through subcutaneous tissues is carried down to the gluteal fascia. The gluteal fascia is then sharply incised over the inferior border of the gluteal muscle. Next, the fascia is elevated off the underlying gluteal muscle using a combination of blunt dissection and electrocautery. The gluteus maximus is then mobilized proximally and laterally and retracted using a broad blunt right angle-type retractor (Table 1). The fascia overlying the hamstring tendons is incised, and any residual hematoma is evacuated. The proximal stump of hamstring tendon is isolated using blunt dissection, clamped with an Alice clamp, and a traction stitch is placed through the distal aspect of the tendon using a #2 FiberWire (Arthrex Inc., Naples, FL) (Fig 2). The tendon is then debrided with a combination of rongeur and knife to remove nonviable tendon tissue. Next, blunt dissection is carried down to the ischium. The footprint of the hamstring tendons on the lateral wall of the ischium is then debrided with a combination of a rongeur and motorized burr. Next, a punch for the 2.6-mm FiberTak (Arthrex, Inc.) anchor is used to mark the hamstring insertion site on the lateral border of the ischium. This site is confirmed with the use of intraoperative fluoroscopy (Fig 3, A and B) (Table 1).

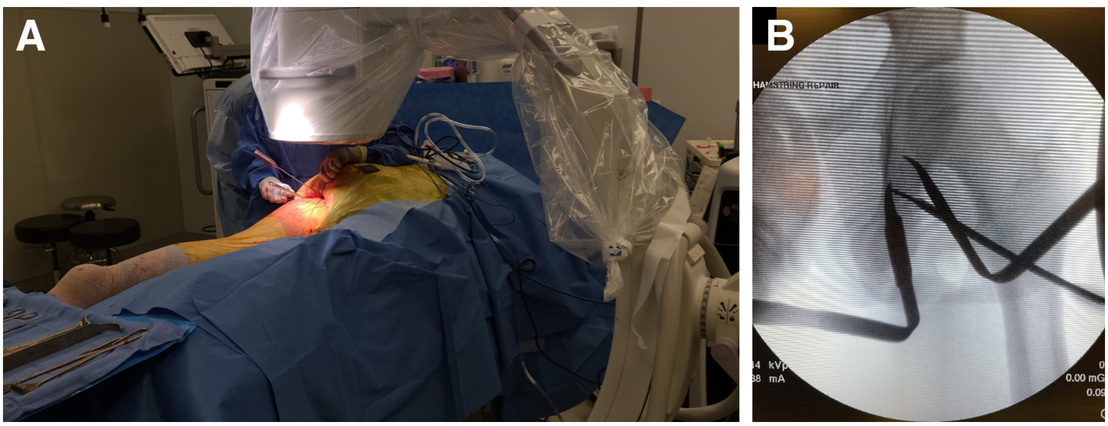

Fig 3. (A) Fluoroscopy setup to confirm the location of the hamstring anatomic footprint. (B) Fluoroscopy image demonstrating correct anatomic placement of suture anchors in the proximal hamstring footprint.

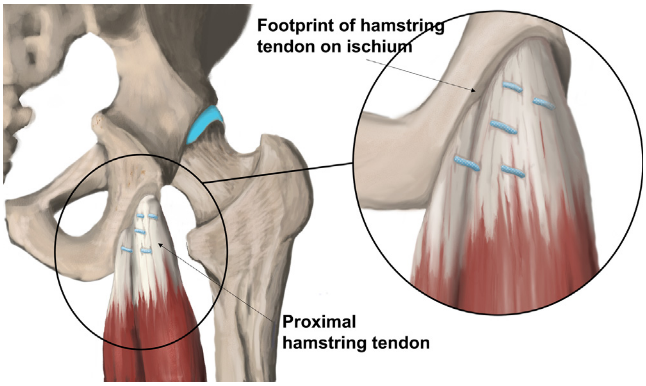

Fig 4. Medical illustration of hamstring tendon footprint with anchors.

Tendon Repair

After confirming the location of the hamstring footprint and ensuring adequate debridement of the bone, five 2.6-mm Knotless FiberTak all-suture anchors (Arthex, Inc.) are placed. Two anchors are placed in the medial and lateral aspects of the distal portion of the footprint. Three anchors (medially, centrally, and laterally) are then inserted into the proximal aspect of the hamstring footprint, completing an "X" configuration (Fig 4, A and B). A free needle is used to pass first the repair suture limb and then the looped limb and tape limbs of the passing suture together, from deep to superficial through the tendon (Fig 5). The repair suture and passing suture limbs from the same anchor are then clamped together. This process is repeated for all 5 anchors. Next, the sutures from the first anchor are unclamped, and the repair limb is fed into the looped end of shuttle suture and shuttled back through the tendon and into the anchor by pulling the tape limb of the shutting suture (Fig 6). After passing all of the repair suture limbs for all 5 anchors, the sutures are then tightened in sequential fashion starting with the distal anchors, and then proximal anchors to advance the tendon back up to its anatomic footprint on the lateral border of the ischium (Figs 7 and 8). For chronic cases, in which the tendon is significantly retracted, the knee can be flexed to reduce tension on the repair and allow for easier tendon advancement. The wound is then copiously irrigated with saline, and the gluteal fascia is closed with #1 STRATAFIX suture (Ethicon, Somerset, NJ). The subcutaneous tissue and skin are then closed in layered fashion, and a dry dressing is applied. Video 1 details this surgical technique.

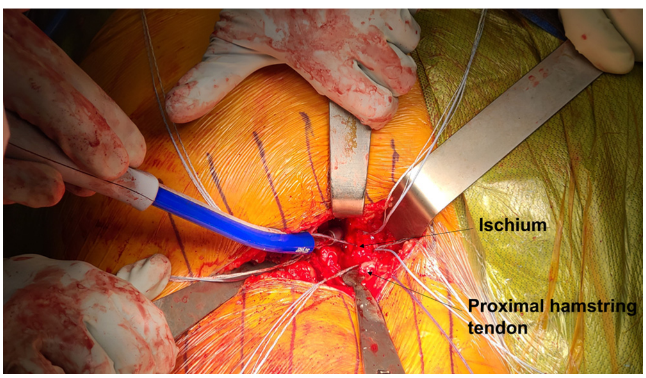

Fig 5. Image demonstrating anchor placement in the lateral ischium.

Fig 6. A free needle is used to pass both the repair and passing sutures through the proximal hamstring tendon in a mattress fashion.

Postoperative Protocol

The patient is given toe-touch, weight-bearing restrictions and placed into a hip brace (DonJoy VersaROM brace, Enovis, Wilmington DE), limiting trunk and hip flexion for a total of 6 weeks (Video 1). Active hamstring exercise is restricted during this time. Physical therapy is initiated in the first week and continued for a total of 4 months postoperatively. For the first 6 weeks, the focus of PT is on gentle motion and assistance with patients toward accomplishing basic activities of daily living. Gentle body weight hamstring strengthening exercises are initiated between the 6^{th} and 8th week, and additional nonimpact activities, such as stationary bike, are added in the 8th to 12th week. The goal of therapy is to achieve full range of motion of the hip, painless aerobic nonimpact activity, and complete all activities of daily living without restriction by 12 weeks.

Discussion

Proximal hamstring injuries are some of the most frequently encountered tendon injuries, accounting for

Fig 7. The repair suture is then shuttled through the tendon and anchor using the looped passing suture. Tension is then applied sequentially starting with proximal limbs and distal limbs to advance the tendon back to its footprint on the ischium.

Fig 8. Image demonstrating the completed proximal hamstring construct.

a large percentage of total musculoskeletal injuries.[4] These injuries occur in both athletes and nonathletes alike and can lead to significant functional impairment.[14] Although lower-grade injuries can be treated nonoperatively with generally favorable outcomes in lower-demand patients, higher-demand patients, including athletes, often continue to complain of weakness and cramping.[3,4] Current guidelines recommend surgical fixation for proximal hamstring tears involving 2 tendons with >2 cm of retraction or complete proximal tendon ruptures involving all 3 tendons.[4-8] Knotless fixation is becoming increasingly utilized in hamstring injuries due to superior biomechanical strength over knotted constructs and decreased technical demand.[11] Additionally, the biomechanical superiority of a larger number of smaller anchors over a fewer number of larger anchors has been demonstrated recently.[15] We present a technique for proximal hamstring repair using 5 small, knotless, all-suture anchors. Our technique combines the biomechanical strength of using multiple smaller anchors with knotless fixation. Lastly, compared to previous knotless techniques, the independent mattress configuration of our technique may improve pullout strength by eliminating interconnected sutures between anchors.[11,16]

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