

Proximal Adductor Avulsion Injuries

Outcomes of Surgical Reattachment in Athletes

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Background: Sports-related groin injuries are common among athletes. However, traumatic proximal adductor avulsion injuries are relatively rare groin injuries in the athletic population, with limited case reports describing suture anchor repair.

Purpose: To report on the outcomes of surgical reattachment of proximal adductor avulsion injuries in athletes utilizing a suture anchor repair technique.

Study Design: Case series; Level of evidence, 4.

Methods: Prospective data were collected on patients undergoing surgical reattachment of proximal adductor avulsion injuries from December 2012 to May 2015 by a single surgeon. Six athletes presented after a traumatic sports-related injury with disabling groin pain, adductor weakness, and magnetic resonance imaging confirmation of fibrocartilage avulsion of the proximal adductor with retraction. Patient-reported outcomes (Hip Outcome Score–Activities of Daily Living [HOS-ADL] and Hip Outcome Score–Sport Specific [SS] subscales, modified Harris Hip Score [mHHS], and visual analog scale [VAS] for pain) were collected preoperatively and at a minimum 2-year follow-up.

Results: The latest follow-up of each patient averaged 33.4 months postoperatively (range, 25–42.5 months). All patients returned to sporting activities, with 1 minor wound complication that resolved. Paired-samples *t* tests indicated that the mean latest postoperative scores for all patients were significantly better than their mean preoperative scores (HOS-ADL: 99.0 vs 43.2, HOS-SS: 98.9 vs 8.3, and mHHS: 97.1 vs 44.6, respectively; $P < .001$ for all). Similarly, there was a significant improvement in mean postoperative VAS scores for all patients (from 89.2 to 2.2; $P < .001$).

Conclusion: Patient-reported outcomes offer an objective measure of hip function and pain control. Surgical reattachment utilizing a multiple suture anchor technique is a successful procedure that allows for a safe return to athletic performance and a predictable return to sport.

Keywords: hip; groin pain; tendon rupture; repair

Sports-related groin injuries are common among athletes.^{8,9} However, traumatic proximal adductor avulsion injuries are relatively rare groin injuries in the athletic population, with limited case reports describing suture anchor repair. One study highlighted that 12% to 16% of

injuries encountered throughout a season in professional football athletes involved the hip or groin region. Of injuries within this region, 64% involved the adductor muscle complex.¹⁹ The mechanism of injury typically involves a noncontact, eccentric load with forced abduction and extension of the hip, resulting in disabling groin pain. Most adductor ruptures occur through the musculotendinous junction, with a rare subset occurring through the fibrocartilage entheses.³ These injuries are predominantly seen in the athletic male population.

Much controversy remains regarding the optimal management of proximal adductor avulsion injuries, with some arguing for surgical fixation and others recommending conservative treatment.^{3,10,12-18} Adductor tenotomy has been advocated for chronic groin injuries in some cases.^{1,2,7} Non-operative management for an acute avulsion generally has good results. However, this treatment may result in continued groin pain and decreased function.¹⁴ The time lost to failed conservative treatment may prove costly to an elite athlete. While surgical reattachment allows the muscle to

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function at its natural working length, it also introduces the risks associated with a surgical intervention.

Limited case reports involving suture anchor repair of proximal adductor avulsion injuries are found within the literature.^{3,10,14,15,18} Of the available series, there is a lack of patient-reported outcomes (PROs) that help quantify how patients function after a surgical intervention is performed. The purpose of this study was to report on the clinical outcomes of surgical reattachment of proximal adductor avulsion injuries in athletes utilizing a suture anchor technique. The hypothesis was that surgical management of this injury would result in a return to preinjury levels of sport with improvement in pain and disability.

METHODS

After institutional review board approval, prospective data were collected on patients undergoing surgical management of proximal adductor avulsion injuries from December 2012 to May 2015 by a single surgeon (S.B.) at a single institution. Six athletes presented after a traumatic sports-related injury with disabling groin pain, adductor weakness, and magnetic resonance imaging (MRI) confirmation of an adductor avulsion injury. Demographic information, injury event details, time from injury to treatment, and time to return to sport were recorded. Three of 6 patients were professional/elite athletes. The remaining 3 patients were competitive at the recreational level. Indications for surgery included a history of sports-related injuries with an acute onset of disabling groin pain. On physical examination, there was evidence of antalgic gait, medial thigh ecchymosis, and tenderness at the proximal origin of the adductor muscle. Furthermore, patients had weakness and pain localized to the proximal adductor origin with resisted adduction and passive abduction on manual testing. An additional surgical indication included an avulsion of the proximal adductor with retraction of greater than 1 cm seen on MRI. Concomitant injuries to the hip and groin aside from adductor avulsions that warranted an operative intervention were also recorded and addressed at the time of surgery.

PROs were evaluated using the modified Harris Hip Score (mHHS) and Hip Outcome Score—Activities of Daily Living (HOS-ADL) and Hip Outcome Score—Sport Specific (HOS-SS) subscales to quantify each patient's preoperative status and postoperative recovery progress. These questionnaires were completed at the preoperative visit and at the 3-, 6-, 9-, and 12-month follow-up appointments. Patients then presented to the office between 2 and 3 years postoperatively to assess long-term improvement in function. Patient-reported pain was evaluated using a 100-point visual analog scale (VAS), with 0 being no pain and 100 being severe pain, at each follow-up visit. We also measured patient satisfaction and the willingness to undergo the procedure again, if indicated.

Surgical Procedure

Either an ilioinguinal or proximal thigh incision was used depending on the need for concomitant procedures. After

the surgical approach, the paratenon of the proximal adductor tendon was identified and incised. Hematomas were evacuated, the fibrocartilaginous adductor complex avulsion was identified, and fibrous tissue was debrided. The footprint of the adductor was identified and cleared of debris with a curette. The footprint was then marked for suture anchor placement, and either two 3.0-mm or four 2.3-mm bioabsorbable suture anchors (Osteoraptor; Smith & Nephew) were seated. Next, the braided polyethylene sutures were passed through the avulsed fibrocartilaginous adductor stump. The sutures were then tied, reducing the avulsed tendon to the footprint with the affected extremity in neutral abduction and 30° of hip flexion. The wound was closed in a typical layered fashion.

Postoperative Rehabilitation

After surgery, all athletes were limited to partial weight-bearing with crutches for 2 to 3 weeks. Extension and abduction were limited to neutral for 4 weeks, after which isometric strengthening commenced. Progressive strengthening of the adductor muscle group was started at 6 weeks, led by an experienced physical therapist. Sport-specific drills were allowed when the patient achieved strength comparable with the nonoperative side and was free of pain during resisted groin adduction. Side-to-side comparison of the adductor strength and the assessment of pain was conducted at 12 weeks postoperatively. Eccentric hip adduction strength was measured manually with the patient in a side-lying position with the leg held straight. The maneuver was repeated on the nonoperative side. Return-to-play criteria included no pain with manual muscle testing and achieving strength equal to the contralateral side.

Statistical Analysis

Statistical analysis was performed using SPSS version 22 (IBM). All data points from the self-administered patient questionnaires were collected and recorded. Paired-samples *t* tests were conducted to examine for differences between preoperative and the latest postoperative HOS-ADL, HOS-SS, and mHHS scores. The significance threshold was set at $P < .05$. Pearson correlations were run to examine for associations between the number of suture anchors, tendon retraction, time to return to sport, and latest postoperative PRO scores.

RESULTS

The 6 acute proximal adductor avulsion repairs were performed in male athletes with a mean age of 38.8 years (range, 33-45 years). Three patients (No. 1, 5, and 6) were actively participating at a professional/elite level in their respective sport. Three patients (No. 2, 3, and 4) sustained an injury during recreational sport (Table 1). Surgical intervention performed and rehabilitation protocol implemented in this series resulted in a return to sport on average 4.8 months (Table 2).

TABLE 1
Demographic and Clinical Findings of Patients^a

Patient No.	Age, y	Side	Sport	Retraction on MRI, cm
1	38	Right	Hockey (goalie, elite)	3
2	35	Right	Soccer	5
3	45	Right	Soccer	2.5
4	38	Left	Golf	2
5	33	Right	Ballet (professional)	3
6	44	Left	Figure skating (professional)	1.3
Mean	38.8			2.8

^aMRI, magnetic resonance imaging.

TABLE 2
Rehabilitation Protocol for Anchor Repair of Proximal Adductor Avulsion Injuries^a

Weeks	Type	ROM Limitations	Basic Content
0-2	Passive	Extension and abduction are limited to neutral	Partial weightbearing with crutches
3-4	Slight active	Extension and abduction are limited to neutral	Isometric strengthening after week 4; weightbearing as tolerated
5-6	Active	—	Progressive strengthening of adductor muscle group
>6	Active	—	Sport-specific drills

^aROM, range of motion.

Clinical Evaluation and Surgical Data

All patients had physical examination findings consistent with an acute avulsion-type injury of the adductor complex: proximal-medial thigh ecchymosis, antalgic gait, pain, and weakness with resisted adduction. All patients were asymptomatic about the hip and groin region before the injury. Also, 1.5-T MRI of the pelvis with a focus on the sagittal and axial oblique series was performed on each patient to detail the integrity of the proximal adductor longus tendon.¹¹ The mean proximal adductor tendon retraction on MRI measured 2.8 cm (range, 1.3-5 cm) (Figure 1).

Patients underwent surgery, on average, 2.7 weeks after the injury (range, 1-5 weeks). A mean of 3.2 suture anchors (range, 2-4 anchors) was utilized for repair of the avulsed fragment back to its footprint. MRI scans of a healed proximal adductor repair 12 weeks postoperatively are shown in Figure 2. The scans were obtained on 1 patient to confirm proximal adductor healing before returning to competitive sport. Patients returned to sport at a mean of 4.8 months (range, 3-8 months). Manual testing of the adductor muscle performed at 12 weeks elicited no pain and showed strength equal to the contralateral side. Five of the patients returned to their preinjury level of sport, and 1 patient

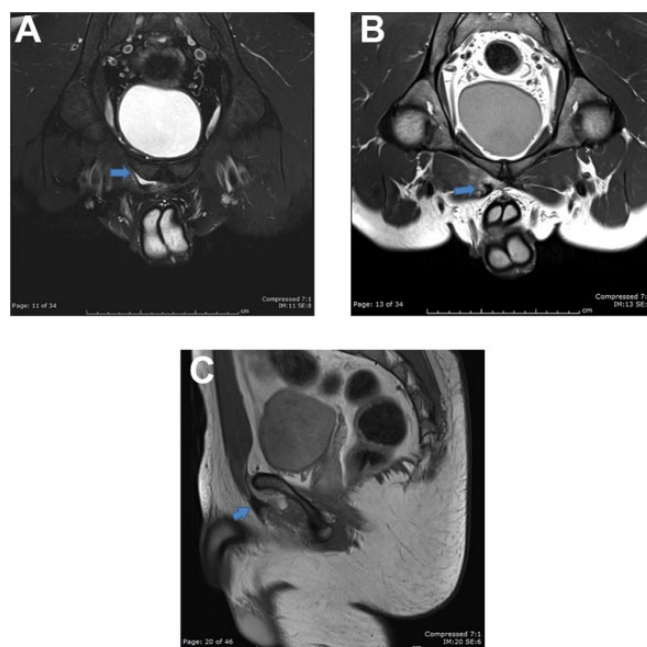


Figure 1. (A) Oblique fat-saturated T2-weighted and (B) proton density-weighted (PD) magnetic resonance imaging (MRI) scans demonstrating a right-sided adductor avulsion injury with 1.7 cm of retraction and fluid signal between the tendon complex and superior ramus (blue arrows). (C) Sagittal PD MRI scan demonstrating an adductor avulsion injury and tendon retraction (blue arrow).

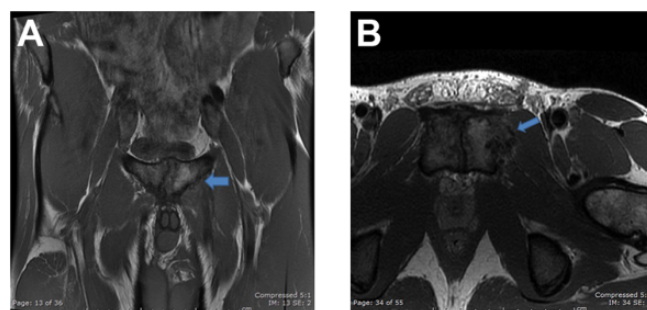


Figure 2. (A) Coronal T1-weighted and (B) axial proton density-weighted magnetic resonance imaging scan demonstrating a healed left-sided adductor avulsion repair site (blue arrow).

resumed play at a lower level of competition (Table 3). All patients had isolated groin injuries.

PROs and Satisfaction

Final PRO measures were completed at a mean of 33.4 months postoperatively (range, 25-42.5 months). Paired-samples *t* tests indicated that for all patients, the mean latest postoperative scores were significantly better than their mean preoperative scores (HOS-ADL: 99.0 vs 43.2, HOS-SS: 98.9 vs 8.3, and mHHS: 97.1 vs 44.6,

TABLE 3
Surgical Data of Patients

Patient No.	Time From Injury to Surgery, wk	No. of Anchors	Time to Return to Sport, mo
1	1	3	3
2	1	4	3
3	4	2	6
4	1	4	6
5	5	2	8
6	4	4	3
Mean	2.7	3.2	4.8

respectively; $P < .001$ for all). Similarly, there was a significant improvement in mean postoperative VAS scores for all patients (from 89.2 to 2.2; $P < .001$). All patients responded they would undergo the operative procedure again, if indicated (Table 4). At 12 weeks postoperatively, all patients achieved adduction strength graded 5 of 5, with no pain during manual resistance testing.

Bivariate Pearson correlation did not reveal any significant relation between the number of suture anchors used and postoperative PRO scores or return to sport. Also, no significant relation was found between the amount of tendon retraction and postoperative PRO scores or return to sport.

There was 1 complication of persistent wound drainage, which required wound re-exploration at 6 weeks postoperatively for suture granuloma removal. This patient successfully returned to training 1 week after wound healing.

DISCUSSION

This study demonstrated that surgical reattachment of proximal adductor avulsion injuries with suture anchor repair leads to a successful return to sport. All patients in this study presented with disabling groin pain quantified by 3 preoperative outcome measures. Patients had MRI-confirmed 1.3 to 5 cm of retraction of the proximal adductor avulsion. The latest PRO scores nearly 3 years postoperatively suggested that this repair technique allows for

continued athletic performance and pain relief. Case series within the available literature have commented on the successful operative management of these injuries.^{3,10,18} This is the first study, however, to include PRO data to offer a more objective measure of surgical repair.

Numerous studies have analyzed the reliability, responsiveness, and validity of the HOS-ADL and HOS-SS as well as the mHHS. A study by Martin and Philippon⁶ supported the use of the HOS for patients undergoing arthroscopic hip surgery, reporting good evidence of reliability and responsiveness of the measure. However, the HOS-ADL and HOS-SS scores were significantly different based on current activity level, surgical outcomes, and age.⁵ The test-retest reliability and content validity of the HOS and mHHS have indicated that they are able to detect meaningful differences between patients who undergo arthroscopic surgery and a control group.⁴

A study evaluating the return to play of National Football League athletes after sustaining a proximal adductor avulsion injury is often cited.¹⁴ These elite athletes were able to return to sport earlier with nonoperative management (average, 6 weeks). However, there is a lack of comprehensive PROs that may allow for a comparison among other series. Furthermore, it is unclear whether these athletes received additional treatment modalities, such as local injections into the adductor complex and/or oral analgesics, to allow for a return to play. In the current study, surgical management allowed for a return to sport at a mean of 4.8 months after the intervention. By comparison, Ueblacker et al¹⁶ reported an average return to play of 88.7 days in their series. Whether an athlete returned to sport symptom-free and maintained that status would give a more complete depiction of treatment efficacy. Verrall et al¹⁷ studied a series of professional Australian male football players treated conservatively for 12 weeks for a chronic groin injury. The next season, 89% of athletes returned to sport. However, only 41% were asymptomatic at the beginning of the next playing season, increasing to 67% by the end of that playing season, nearly 52 weeks after diagnosis and treatment.¹⁷ Overall, objective follow-up data in addition to PROs may offer more clarity on the operative and nonoperative management of these injuries in athletes.

TABLE 4
Patient-Reported Outcome Scores^a

Patient No.	Preoperative				Postoperative				Patient Satisfaction
	mHHS	HOS-ADL	HOS-SS	VAS	mHHS	HOS-ADL	HOS-SS	VAS	
1	30.8	36.8	0.0	90	100	100	100	5	Yes
2	41.8	44.1	0.03	90	100	100	100	3	Yes
3	53.9	47.1	25.0	90	82.5	94.1	91.7	0	Yes
4	33	42.6	25.0	90	100	100	100	0	Yes
5	51.7	41.2	0.03	95	100	100	100	0	Yes
6	56.1	47.1	0.03	80	100	100	100	5	Yes
Mean	44.6	43.2	8.3	89.2	97.1	99	98.9	2.2	

^aHOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sport-Specific; mHHS, modified Harris Hip Score; VAS, visual analog scale.

The type of concomitant injury being addressed dictated the surgical approach in this study. The ilioinguinal approach was utilized in the 3 patients requiring groin repair or rectus abdominis repair. A proximal medial thigh incision was utilized in pure adductor injuries and in the patient who underwent arthroscopic management of femoroacetabular impingement. Studies entailing operative repair of adductor injuries utilized a bikini-type incision measuring 5 to 6 cm long³ and an 8-cm longitudinal incision starting just distal to the inguinal ligament.¹⁸ Other case series did not comment on the management of any concomitant abnormality that was encountered in their patients.

There currently is no consensus in the literature regarding the optimal number of suture anchors for surgical repair of adductor avulsions. The senior author changed his technique during the study period from two 3.0-mm suture anchors supplemented with FiberLoop suture (Arthrex) to utilizing four 2.3-mm suture anchors for repair. Anywhere from 2 to 7 suture anchors have been used for fixation of adductor avulsions^{3,10,14,18} (Table 3). Currently, we are conducting a biomechanical study comparing two 3.0-mm versus four 2.3-mm suture anchors during repair of the proximal adductor.

We experienced 1 complication of wound dehiscence that was successfully managed with surgical wound debridement. One additional complication of heterotopic ossification and wound drainage was encountered with surgical repair in a previously reported series, both of which eventually resolved.¹⁴ This represents an inherent risk of surgical management; however, these were minor complications that were appropriately managed and had no effect on final outcomes.

Return to sport in 4 of the 6 patients may have been prolonged because of additional procedures performed during adductor repair. Isolated operative repairs of the adductor longus throughout series within the literature have reported return-to-play times of anywhere from 8 to 21 weeks. The average age of patients in other studies ranged from 21 to 43 years.^{3,10,14,15,18} A study of 15 high-level athletes who underwent suture anchor reconstruction involving the proximal adductor tendon and conjoint tendon of the internal oblique and transversus abdominis muscles reported a return to play at an average of 13 weeks (range, 10-21 weeks).¹⁴ Series detailing the nonoperative management of adductor avulsion injuries cite a return to play of 6 to 13 weeks in patients with an average age of 28 years.^{14,16}

It is possible that the relatively older athletes encountered in our series, in addition to the concomitant procedures performed, led to a longer return to play. Still, the quality of return to play, being completely asymptomatic about the hip and groin, was experienced by all patients in our series, as supported by long-term hip outcome scores, which are lacking in other series. The technique utilized in this series was novel, and thus, the duration of postoperative rehabilitation before return to play was not clearly established. However, 50% of the patients were able to safely return to sport as early as 12 weeks. This is dependent on achieving strength comparable with the nonoperative side and the absence of pain with manual adductor muscle testing.

Limitations of this study include a small sample size and no control group for nonoperative management. It is possible that a larger sample size may reveal significant relations between the amount of tendon retraction, number of suture anchors used, and overall postoperative functional outcomes of a patient. Additionally, there was a lack of sensitive muscle testing. Injuries aside from adductor avulsions underwent surgical management in 4 of 6 patients. The recovery and rehabilitation from these additional procedures may have obscured the reported outcomes, contributing to the extended delay in return to sport compared with isolated adductor avulsion injuries in other series.^{10,18} However, patients undergoing just suture anchor repair of an adductor avulsion recorded improvements in pain and function similar to the multiprocedure subset.

Another limitation of this study is the mean patient age of 38.8 years, which is notably higher than the average age in other series. Although older, they still represent a cohort competing at a high level in their respective sport. Our cohort was inhomogeneous with regard to the level of competition, type of sport, and concomitant injuries suffered. However, these injuries are quite rare and complex overall. Having here reported a repair technique performed on athletes with an infrequently encountered injury who participate in various types of sport, we hope to offer the treating physician reassurance in managing this injury.

CONCLUSION

Proximal adductor avulsion injuries occur in the athletic male population. Surgical reattachment utilizing a multiple suture anchor technique is a successful procedure that allows for a safe return to athletic performance at a mean of 4.8 months, with a low risk of complications. A significant improvement in PRO scores was experienced. Concomitant abnormalities can be addressed at the time of surgical repair.

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