

Operative Treatment of Proximal Rectus Femoris Injuries in Professional Soccer Players

A Series of 19 Cases

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Background: Proximal rectus femoris (PRF) tears are relatively rare injuries among top-level athletes. PRF injuries can be avulsions of both tendon heads (direct and reflected heads) or of a single head, and some have a tendency to progress to recurrent injuries.

Purpose: To describe a series of operatively treated PRF ruptures in professional soccer players.

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

Methods: Nineteen cases of PRF injuries (18 patients, 1 bilateral) in professional soccer players who were treated surgically were retrospectively reviewed. Perioperative findings with return-to-play data were recorded.

Results: Of the PRF injuries, 10 total avulsions (both heads) and 9 single-head tears were seen on magnetic resonance imaging and were later confirmed during surgery. All 18 patients returned to their preinjury level of play (mean follow-up, 2.8 years [range, 1-11 years]).

Conclusion: The repair of PRF tears in professional soccer players yielded good results and allowed all patients to return to their preinjury level of play.

Keywords: proximal rectus femoris injury; surgical treatment; sports injury; soccer

Proximal rectus femoris (PRF) injuries at or near the anterior inferior iliac spine are uncommon in professional American football or soccer players based on previous studies.^{5,6} Although strains of the rectus femoris muscle are relatively common injuries in soccer,²¹ most of them heal

well with nonoperative treatment.¹² The rectus femoris muscle has an origin and insertion over 2 big joints, the hip and knee, which cause high mechanical stress especially during a soccer kick.³ PRF injuries have earlier been described in adolescent and young patients as well as in athletes of several sports such as soccer, football, and sprinting.^{5,8,11} In 2009, Gamradt et al⁵ published a series of PRF injuries in professional American football players treated nonoperatively with good results. However, these injuries only involved the direct head of the rectus femoris. More recently, several authors have reported good results with the operative treatment of PRF avulsions in high-level athletes.^{2,17} Sonnery-Cottet et al¹⁷ recommended the operative treatment of injuries involving both heads of the rectus femoris.

Because of the recent indications and research presented on this topic, we retrospectively reviewed operatively treated PRF injuries at our institution to demonstrate that physicians treating these injuries should be aware of the possibility for operative treatment of PRF injuries.

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TABLE 1
Data of Surgically Treated Proximal Rectus Femoris
Injuries in Professional Soccer Players^a

Characteristic	Specification
No. of patients	18 male, 1 with bilateral injuries (1.5 y between injuries)
Patient age, mean (range), y	23.4 (15 to 31)
Diagnosis	MRI findings and all diagnoses confirmed at surgery
Time of diagnosis, mean (range)	2 wk (1 d to 2 mo)
Time of surgery	
Acute surgery <3 mo (13 patients, 14 procedures), mean (range), d	27 (1 to 75)
Late surgery >3 mo (5 patients)	At 3, 4, 7, 8, and 9 mo

^aMRI, magnetic resonance imaging.

METHODS

From 2004 to 2016, we encountered 19 cases of PRF injuries (in 18 male professional soccer players; 1 bilateral case), which were treated operatively with suture anchor fixation (ICONIX; Stryker). The retrospective patient data are presented in Table 1 and the PRF injury patterns in Figure 1: acute tears constituted one-third of type B and two-thirds of type C, whereas chronic tears constituted one-third of type C and two-thirds of type D.

Patients referred to our institute had a typical history of PRF injuries: sudden pain during hip extension or forceful flexion, together with weakness and pain during hip flexion. The primary diagnosis was made using magnetic resonance imaging (MRI) of the pelvis, which is the main diagnostic imaging tool for PRF injuries; 13 of the injuries occurred on the right side and 6 on the left side. Acute surgery was performed on patients with clear retraction of both tendon heads, while later surgery was conducted after failed conservative treatment. Figure 2 shows preoperative imaging of an operatively treated PRF injury with a complete 2-tendon avulsion (both direct and reflected heads) (Figure 2A) and a proximal common tendon rupture (Figure 2B). Eleven patients (12 injuries) were treated surgically during the first 3 weeks after the injury. In 7 patients, the injury was interpreted as partial and was first treated nonoperatively until recurrent injuries occurred or pain and weakness prevented training and full return to play.

The outcomes were quantified as good (full return to pre-injury level of sports without any symptoms) or moderate (return to preinjury level of sports with some residual symptoms).

Surgical Technique and Postoperative Rehabilitation

An approximately 10-cm skin incision was made over the rectus femoris insertion longitudinally (Figure 3) and the fascia was opened. Surgeons should be aware of the lateral

femoral cutaneous nerve branches that run along the sartorius muscle. After the sartorius muscle was shifted medially, the ruptured rectus femoris stump was visualized and reinserted to the anterior inferior iliac spine with 1 to 2 suture anchors (ICONIX) with simple stitches utilizing gliding. Anchors were also used in cases of partial or recurrent tears to make the thinned and possibly elongated proximal muscle stronger. At surgery, the goal was to restore the tonus of the ruptured and retracted muscle back to normal. As the elongated scar tissue did not withstand the mechanical stress, sutures were used for reinforcement.

The postoperative rehabilitation protocol is shown in Table 2. After reattachment of the ruptured PRF, the patients used crutches for 1 to 2 weeks. However, full weightbearing with small steps was allowed within the limits of pain. No braces/orthoses were used. Patients were advised to keep the operated side on a pillow, keeping the hip slightly flexed. Then, slow stretching exercises of the hip joint to all directions were started as well as walking, swimming, and pool training. Cycling and aqua weight training were started 4 weeks after surgery. Eccentric exercises were allowed 6 weeks after surgery and jogging and running 8 weeks after surgery. Physical therapy was prescribed this whole time, concentrating on balance, coordination, and strength. Ball training and kicking were started between 2 and 3 months after surgery as well as sprinting and jumping. Physicians performed clinical strength measurements at 3 and 6 months after surgery, and if hip flexion strength was approximately equal to the contralateral side, permission to return to play was given.

RESULTS

Of the PRF injuries, there were 10 total avulsions of both the direct and the reflected tendon heads at the anterior inferior iliac spine and 9 tears of a single head. Postoperatively, results were evaluated as good in 17 cases and moderate in 2 cases. All players were able to return to their preoperative level of sports (mean follow-up, 2.8 years [range, 1-11 years]). Some players were able to participate in full training as soon as 3 months after surgery. The findings on MRI correlated well with the perioperative findings. In 3 patients who underwent late surgery for recurrent injuries, calcification was noted within the injured tendon. These fragments were measured 1, 2, and 3 cm at their largest diameter. Wound healing was delayed for 2 weeks in 1 patient. Two players had permanent local loss of normal sensibility by an injury to the lateral femoral cutaneous nerve branches, which did not interfere with their function.

DISCUSSION

In this study, we describe a series of PRF ruptures in professional soccer players that were all treated operatively after acute or recurrent injuries. After suture anchor fixation of PRF injuries, the athletes returned to the same pre-injury level of competition with high probability. Our results of return to play are in line with those of earlier

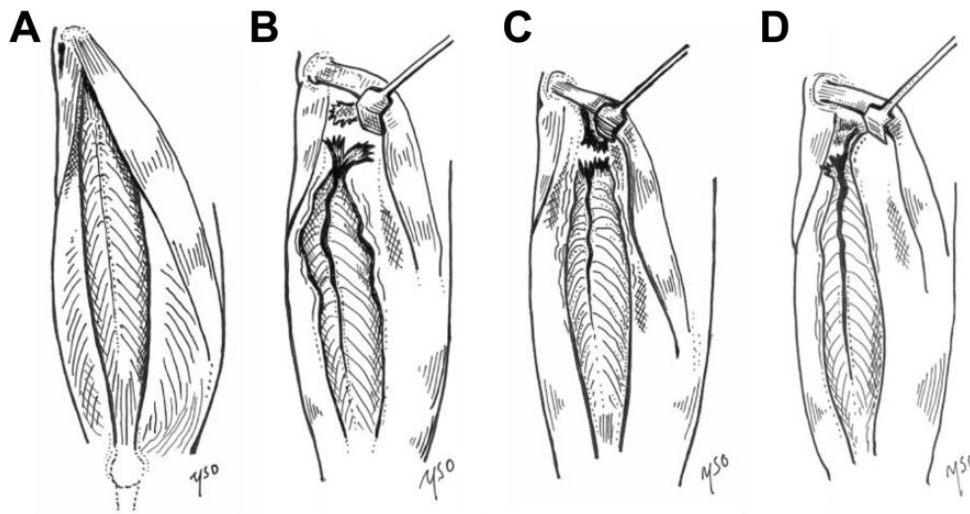


Figure 1. Schematic illustrations of different proximal rectus femoris tear patterns. (A) Normal anatomy. (B) Complete 2-tendon avulsion. (C) Complete rupture of the proximal common tendon. (D) Partial tear of the proximal rectus femoris (direct head).

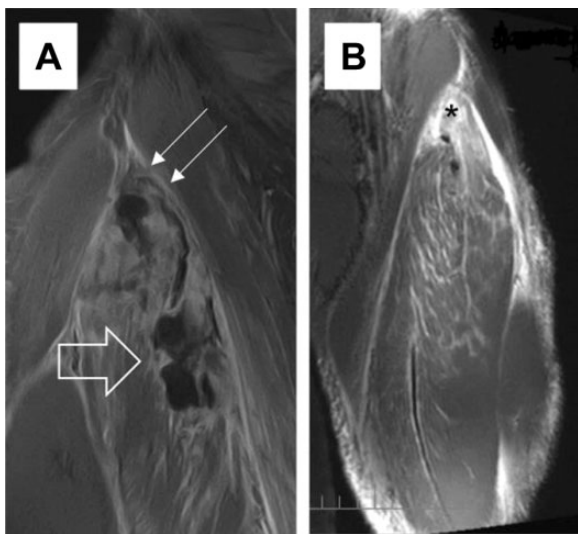


Figure 2. Magnetic resonance imaging (coronal) of the proximal rectus femoris showing (A) an acute total avulsion of both tendon heads (direct and reflected) and (B) a complete rupture of the proximal common tendon (asterisk). In (A), double arrows show the origin of the proximal rectus femoris, and the single arrow shows the retracted conjoint tendon.

reports that examined the operative treatment of PRF injuries in smaller sample sizes with the same sports and levels of competition.^{6,17,19}

In the literature, the exact location of the injury is often inadequately presented, which makes it difficult to compare different studies. The tear may be an avulsion of the tendon from bone or a rupture involving the proximal tendinous part as well as a partial proximal rupture. These different injuries may vary in their natural course. The differing anatomies of direct and reflected tendon heads

have been described.^{7,14} This anatomic variance between the angles as well as tendon morphology (tapered or cord) of the direct and reflected tendon heads should be kept in mind when dealing with PRF injuries. PRF injuries can be divided into acute and chronic as well as total avulsions and partial tears.²⁰ The treatment of any PRF injury can be nonoperative in sedentary people and in physically low-demand athletes.^{4,8} As activity levels vary between different sports, even top-level American football players have been treated without surgery with good results.⁵ However, in the study of Gamradt et al,⁵ only avulsions at the anterior inferior iliac spine were shown, without mentioning retraction of the reflected head.

Sonnery-Cottet et al¹⁷ proposed an algorithm for the treatment of PRF injuries. Based on this algorithm, total avulsions of the PRF should be treated operatively in professional athletes, whereas partial tears of the PRF might be managed without surgery. It is our belief that if clinical findings, together with MRI, show that both the direct and reflected tendon heads are ruptured, a high-demand athlete benefits from reattachment of the PRF. Overall, it seems that most of the injuries in the proximal insertional area are primarily suitable for conservative treatment, and outcomes are mainly good even in complete avulsions with some retraction.⁵ However, healing sometimes does not progress as expected, and return to play is delayed. This can occur in both complete and partial tears, as presented in the current study.

In elite soccer, in which the athlete has to perform forceful kicking and maximal sprinting, surgical restoration of the injured tendon seems to be a viable choice for total avulsions of the PRF.^{1,9,11} Previously, Garcia et al⁶ and Sonnery-Cottet et al¹⁷ reported a total of 9 cases (4 and 5 patients, respectively) of the PRF treated successfully by surgery in professional soccer players, although the patients that they treated were older compared with our participants. In addition, return to play seems to be over 3 months after PRF reattachment even if platelet-rich

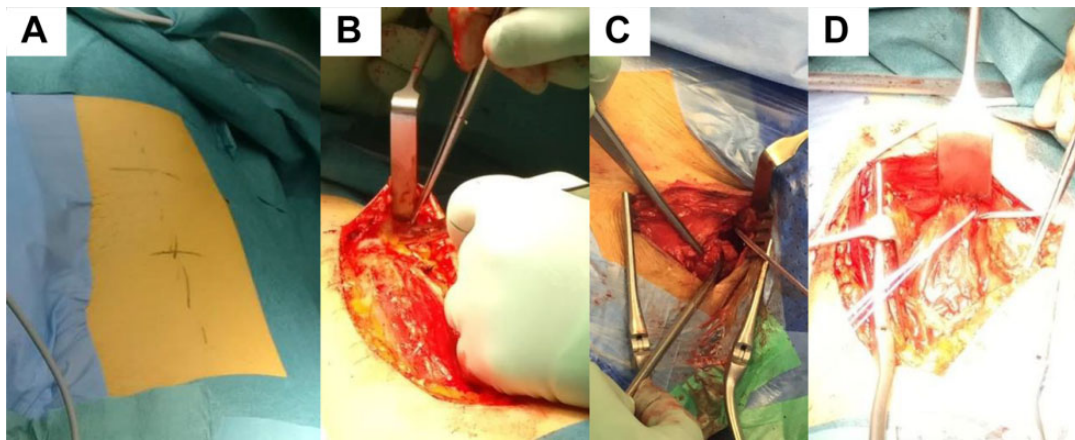


Figure 3. Intraoperative images of the surgical technique for the repair of a proximal rectus femoris avulsion. (A) Skin incision. (B) Opening the fascia. (C) Identifying the proximal rectus femoris stump with both direct and reflected tendon heads. (D) Repair is secured with suture anchors, and the sartorius muscle is turned medially by a spreader.

TABLE 2
Postoperative Rehabilitation After the Operative
Treatment of Proximal Rectus Femoris Injuries

Postoperative Rehabilitation	Weeks After Surgery
Use of crutches and pain-free walking	1-2
Pool training	3-4
Bicycling and weight training	8-12
Ball training with kicking, sprinting, and jumping	12-24
Full training and return to play	12-30

plasma is applied during surgery.⁶ While total avulsions of the PRF are treated operatively, the treatment strategy of PRF partial tears could have more options. Dean et al² proposed the indications and contraindications for the surgical treatment of PRF injuries. These indications were high-demand patients (high-level athletes) and failure of nonoperative treatment (pain and weakness for over 3 months), whereas contraindications were described as nondisplaced avulsions, tears without retraction, and low-demand patients in whom chronic tears do not interfere with normal daily function.² These indications are also in line with our practice.

Interestingly, previous studies have not taken into consideration the 2 different origins of the PRF, the direct and reflected heads, and whether surgical treatment is indicated in isolated 1-tendon injuries. According to our experience, MRI can detect patients who could benefit from surgery by showing enlarged diffuse hematoma at the original insertion of the PRF as a sign of a ruptured fascia as well as a retracted tendon stump. Dean et al² postulated that nonoperative treatment leads to good results if the PRF tear has minimal retraction, with which we also agree. When PRF tears have minimal retraction and the fascia over the ruptured tendon is intact, nonoperative treatment leads to good results.

Previously, much research has been conducted regarding juvenile bony avulsions of the PRF compared with adult non-bony PRF injuries.^{10,13,15,16} While these authors concluded

that retraction of bony avulsions of the PRF could result in worse outcomes in high-demand patients, this same retraction of the tendon also occurred in the present study. If the anatomy of the PRF injury is not restored adequately, the strength of the rectus femoris could be diminished.¹⁸ This poorly healed tendon stump develops a painful and cramping area of scarring, which prevents the player from participating in full competitive play. A PRF injury could become chronic because of poor healing after the primary injury, too early of a return to competitive sports, or after recurrent injuries. If these chronic and often recurrent injuries compromise the full competitive participation of the player, operative treatment could be necessary for partial tears of the PRF.

The operative treatment of complete PRF ruptures has typically a good prognosis in professional soccer players. The tear can be sutured,⁶ the proximal tendon heads of the rectus femoris can be excised, or the tendon can be reattached and secured with suture anchors.^{9,19,20} According to our results and those of others,^{6,9,17,19} it seems that good outcomes may be expected after operative treatment in most cases of complete or 1-tendon PRF tears. However, in the acute phase, surgery is technically easier compared with surgery performed in the chronic phase or after recurrent injuries. If persistent symptoms or recurrent injuries occur after nonoperative treatment, surgery may be indicated.

The main limitation of this study is our retrospective design, and clinical controls were not determined preoperatively, including only male patients. Also, the strength measurements were conducted in a clinical manner, and no actual objective measurements were used. Future studies are warranted to evaluate the benefits between nonoperative and operative treatment in different patient populations, especially in the case of incomplete ruptures.

CONCLUSION

The operative repair of acute PRF injuries involving both tendon heads allowed professional soccer players to return to their preinjury level of play. The surgical treatment of

single-head PRF injuries with persistent or recurrent symptoms also yielded good results. The surgical repair of PRF injuries is a viable treatment option in elite soccer athletes. Further studies are needed to help determine which patients will benefit from the early surgical treatment of PRF injuries.

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