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SPORTS MEDICINE

Returning to sports after surgical repair of acute proximal hamstring ruptures

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Abstract
Purpose Although the treatment of choice for acute proximal hamstring ruptures is now surgical repair, this technique is relatively new and requires further evaluation. Our hypothesis was that patients return to sports at the same level after surgical repair as before injury.
Methods From 2002 to 2011, a prospective observational study including 34 patients, mean age 39.3 ± 11.4 years old underwent surgical repair of an acute proximal hamstring rupture. Surgical, rehabilitation and follow-up protocols were standardized. Mean follow-up was 27.2 ± 22.9 months and there were no lost to follow-up. The primary outcome was the level of activity on the UCLA and Tegner scores.
Results The mean UCLA score was 9.1 ± 1.3 before injury and 8.7 ± 1.7 at the final follow-up ($p = 0.03$). The median Tegner activity level was 6 (range, 4–10) before injury and 6 (range, 3–10) at the final follow-up ($p = 0.05$). The two scores were correlated ($r = 0.76$, $p = 0.00001$). Patients returned to sports within a mean 5.7 ± 1.6 months, at the same level in 27 patients (79.4 %) and at a lower level in 7 patients (20.6 %). The average hamstring/quadriceps ratio at 240°/second was 54.7 ± 8.6 % which was positively correlated to the level of activity on the UCLA score ($r = 0.49$, n.s.). The level of satisfaction was related to their level of activity at the final follow-up ($p = 0.03$).
Conclusion Although surgical repair of acute proximal hamstring ruptures has significantly improved the functional prognosis of patients it remains a serious condition that can compromise future sports activities.
Level of evidence Case–control study, Level III.

Keywords Acute proximal hamstring rupture · Surgical repair · Activity level · Return-to-sports

Introduction

The first cases of proximal hamstring rupture were reported in the literature in 1988 [12]. The study by Koulouris and Connell [17] showed that only 12 % of hamstring muscle injuries were proximal ruptures and 9 % were complete.

In 1996, Sallay et al. [20] showed that the functional results after surgical repair were better than those after conservative treatment. Patients may undergo surgical repair after conservative treatment has failed [6, 8, 13, 18] and recover satisfactory function. Cohen and Bradley [7] recommend surgery in cases of tendon rupture, when a bone fragment has moved more than 2 cm, or with complete rupture. Although some case reports [16] have described successful treatment with conservative medical treatment, surgery is now the rule. A recent review of the literature has confirmed that surgery is the best option in these cases [10].

Acute ruptures must be differentiated from chronic ruptures based on to the time between injury and surgical repair. According to Klingele and Sallay [14] 4 weeks after injury surgery becomes more difficult because of the

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development of early fibrosis around the sciatic nerve. This technical difficulty has also been mentioned by other authors [4, 11, 19]. These two populations must be analyzed separately because the functional outcomes seem to be improved [10] if surgical repair occurs within 4 weeks after injury.

The main aim of this study was to obtain a detailed and quantified description of the level of activity before injury and compare this to the level of activity after surgery. The hypothesis was that the patient could reach the same level of activity after surgical repair of an acute hamstring rupture as before injury after a minimum follow up of 6-month. The secondary aim of this study was to investigate the predictive factors for returning to the same level of activity at the final follow-up.

Materials and methods

A prospective single-center observational study was performed between 2002 and 2011. Patients were fully informed and the study was approved by the ethics committee for a non-interventional study.

Inclusion and exclusion criteria

Inclusion criteria were (1) partial or complete hamstring proximal rupture, (2) acute rupture (treated less than 4 weeks after injury) and (3) surgical treatment. Diagnosis of the rupture was based on clinical signs: violent pain in the buttocks after the injury followed by weakness in the leg and weight-bearing was impossible. A hematoma developed in the posterior thigh and there was a palpable gap distal to the ischial tuberosity. Emergency MRI confirmed the rupture.

MRI protocol

Bilateral coronal and axial T1 and T2 fat-suppressed sequences were obtained. MRI diagnostic criteria for the rupture included a hematoma and tendon retraction with a typical bell-hammer appearance. Tendon retraction (cm) could also be measured on MRI as well as the density of involved muscles.

Surgical procedure

The surgical procedure was identical for all patients. The patient was installed in the prone position under general or spinal anesthesia. The hip was slightly flexed (20°) and the knee was flexed (90°) on a knee bar, allowing relaxation of the hamstrings. A short vertical 6–8 cm incision was made in the gluteal fold and at the base of the ischial tuberosity.

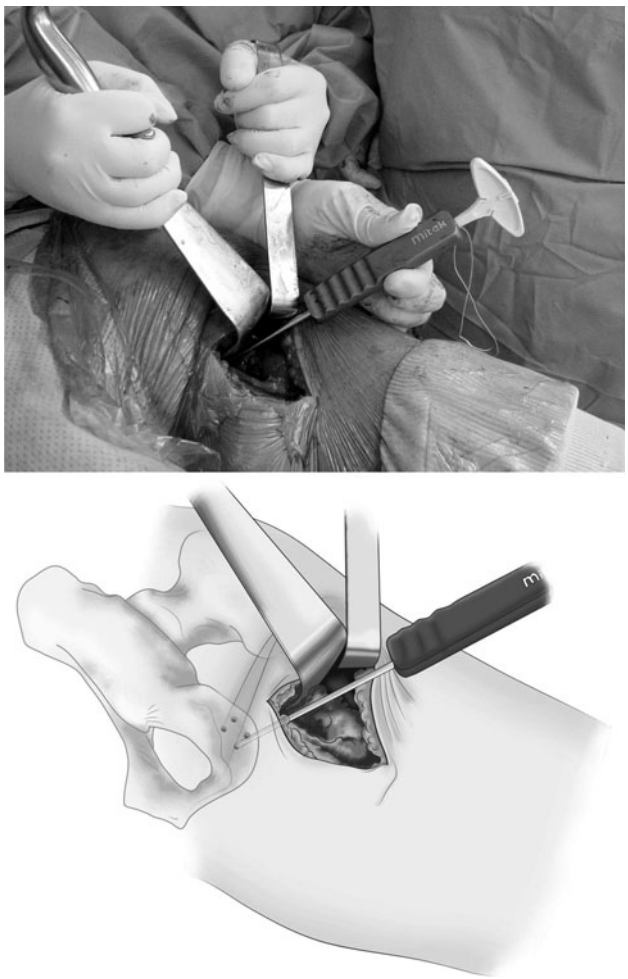

Fig. 1 Anchor Lupine™ implementation

After opening the superficial fascia, severed and retracted tendons were easily identified, the sciatic nerve could be seen and neurolysis performed. Transosseous tendon reinsertion was performed with both metallic (Fig. 1) or absorbable anchors and non-absorbable sutures (Orthocord™ Suture, DePuy Mitek, Norwood, Massachusetts) (Fig. 2). Anchors were metallic (Mitek GII SuperAnchor™) in patients treated before December 2007 and absorbable (Mitek Anchor Loop Lupine™) after this date. For the latter, the system-specific Lupine™ cannulated drill guide enabled drilling of the ischium without risk of injury to the sciatic nerve.

Rehabilitation protocol

For the first week, the knee was immobilized by a simple splint flexed at 30° to prevent traction on the suture. Weight-bearing was partial and on crutches. For the next 5 weeks, the splint was replaced by a custom made, hinged knee brace allowing free knee flexion but limited extension at 30°. Gentle, progressive functional rehabilitation was

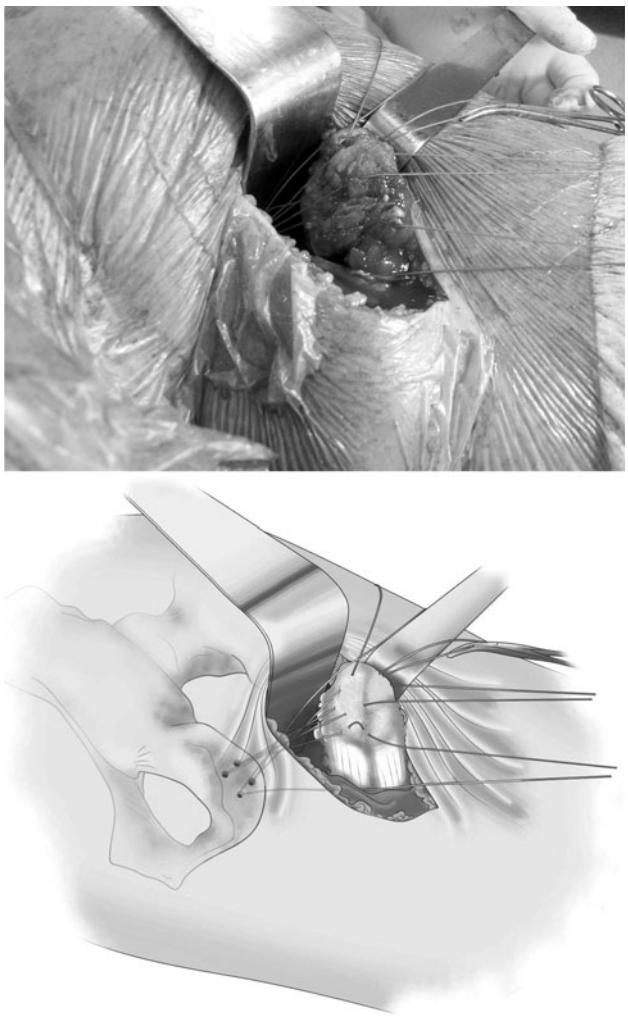

Fig. 2 Transosseous tendon reinsertion

begun with isometric quadriceps and hamstring exercises, with the knee flexed at 30°. Full weight-bearing and sitting were allowed if there was no pain. On the sixth week, the knee was released and full weight-bearing was allowed without a cane. Active rehabilitation included progressive dynamic hamstring exercises and closed kinetic chain exercises for the quadriceps. The patient could then begin low resistance, rapid rhythm (80/min) biking. Balneotherapy was also begun during this phase. Between weeks 12–16, the patient began fast walking and if possible light jogging. Concentric then eccentric isokinetic hamstring muscle strengthening was performed. Regular sports activities could be started between weeks 16 and 32.

Follow-up protocol

Post-operative clinical assessment was performed at 6 weeks, 3 months, 6 months, 1 year and then every 3 years. MRI monitoring and isokinetic Biodex® tests were performed at the 6-month follow-up at least.

Patient evaluation criteria

The primary outcome was the level of activity level according to the UCLA [1] and Tegner [23] scores before injury and at the 6-month follow-up at least. The secondary end points were time to return to sports, the time spent out of work, tendon healing on MRI, hamstring/quadriceps ratio, isokinetic testing at 240° per second, and at the final follow-up, residual pain and/or sciatic nerve block and a satisfaction questionnaire (very satisfied, satisfied, moderately satisfied, disappointed).

Patients

Sixty patients in the department underwent surgical repair of complete or partial proximal hamstring ruptures during the study period, including 34 patients within 4 weeks after injury. The series of acute ruptures included 9 women and 25 men, mean age 39.3 ± 11.4 years old. The right side was affected in 22 patients and the left side in 12 patients. Two patients did not practice any sports, three were professional athletes, 12 were practicing competitive sports and 17 recreational sports. The mechanism of injury was similar; a combination of hyperflexion of the hip, hyperextension of the knee with violent eccentric contraction of the hamstring muscles. No direct trauma was reported to the ischial tuberosity. The injury occurred during a sports activity in 29 patients (85.3 %) and a domestic accident (slipping) in 5 patients (14.7 %). The movements responsible for the injury were forced splits (rugby, fencing, jogging and sliding), high acceleration (rugby, skeleton and water-skiing) or shooting into space (football). All patients were referred directly to the department. The patients had various clinical signs of hamstring rupture (Table 1). Fifteen patients presented with an ultrasound obtained within a mean 3.7 ± 2 days after injury showing a hematoma in all cases and suggesting partial hamstring rupture in 3 cases. MRI was performed a mean 5.9 ± 3 days after injury and confirmed the diagnosis of rupture in all cases with a mean shrinkage of 5.7 ± 2.3 cm.

Patients were treated surgically by two senior surgeons a mean 13.6 ± 6.4 days after injury. Tendon rupture was complete in 23 patients (5 periosteal avulsions), partial for two tendons (biceps and semitendinosus) in 7 patients and a single tendon (semimembranosus) in 4 patients. MRI diagnosed partial rupture in 8/11 patients with this entity. The average perioperative shrinkage was 5.8 ± 1.9 cm. The average number of anchors used was 3.4 (2–4), metallic in 12 patients treated before December 2007 and absorbable in 22 patients treated after that date. Postoperative complications included a large hematoma that required emergency evacuation in one patient. MRI control was performed in 19 (55.9 %) patients after a mean

Table 1 Clinical signs frequency

Clinical signs	Number of patients (Total 34)
Feeling of	
Crackle	13 (38.3 %)
Bang	5 (14.7 %)
Tear	5 (14.7 %)
None	11 (32.3 %)
Stabbing pain during the trauma	15 (44.1 %)
Intensity of pain during the trauma	
Syncopal	5 (14.7 %)
Strong	25 (73.5 %)
Moderate	4 (11.8 %)
Intensity of pain when seated	
Strong	15 (44.1 %)
Moderate	11 (32.3 %)
Slight	4 (11.8 %)
None	4 (11.8 %)
Sciatic pain	
None	30 (88.2 %)
Slight	2 (5.9 %)
Moderate	2 (5.9 %)
Posterior hematoma	
Important	19 (55.9 %)
Moderate	7 (20.6 %)
Small	8 (23.5 %)
Muscle weakness	
Important	21 (61.8 %)
Moderate	12 (35.2 %)
Slight	1 (3 %)

15.8 ± 19.6 months and isokinetic testing in 17(50 %) patients a mean 10.9 ± 5.6 months after surgery. No recurrent ruptures occurred during follow-up. Mean follow-up was 27.2 ± 22.9 months. There were no lost to follow-up patients.

Statistical analysis

Normal distribution was determined by the Shapiro–Wilk test. If distribution was normal, parametric tests were used: the Student t- test for quantitative variables and the Mac Nemar or Chi2 test for qualitative variables. If distribution was not normal nonparametric tests were used: the Mann–Whitney or Wilcoxon test for quantitative variables and the Fisher exact or Mac Nemar test for binary variables. Differences were tested with the Kruskal–Wallis test. Correlations were identified by the Pearson's test. A p value less than 0.05 was considered to be statistically significant.

Results

The average activity level according to the UCLA score was 9.1 ± 1.3 before injury and 8.7 ± 1.7 at the final follow-up ($p = 0.03$). The median Tegner activity score was 6 (range, 4-10) before the trauma and 6 (range, 3-10) at the final follow-up ($p = 0.05$). The two scores were strongly correlated ($r = 0.76$, $p = 0.00001$). All patients who practiced sports (32/34) resumed their activity within a mean 5.7 ± 1.6 months, at the same level in 27 patients (79.4 %) and at a lower level in 7 patients (20.6 %). Of the 15 athletes in the series, 12 (80 %) return to sports at the same level. Patients stopped working for a mean 3.2 ± 1.5 months.

The hamstring tendon was found to be healed on MRI after a minimum 6-month follow-up in all patients. No fatty muscle degeneration or atrophy was present. The average hamstring strength on isokinetic tests was 92.7 ± 18 %, 93.8 ± 16.2 % and 100.8 ± 12.5 % at 90, 180 and 240° per second respectively compared to the contralateral limb. The average hamstring/quadriceps ratio was 54.7 ± 8.6 % at 240° per second. The IJ/Q ratio was positively correlated to the level of activity on the UCLA score ($r = 0.49$, n.s.).

At the final follow-up, 8.8 % of patients had mild discomfort or pain during prolonged sitting. One patient underwent tendon carding at 71.5 months follow-up due to hamstring tendinopathy following migration of a metallic anchor. There were no cases of sciatica nerve block. There were twenty-six (76.5 %) very satisfied patients, 4 (11.75 %) satisfied, four (11.75 %) moderately satisfied and no disappointed patients. Patient satisfaction was related to the level of activity at the final follow-up based on the UCLA score ($p = 0.03$) with a mean 9.2 ± 1.1 in very satisfied patients, 7.7 ± 1.5 in satisfied patients and 6.5 ± 2.9 in moderately satisfied patients.

Predictive factors for returning to the same level of activity were investigated including age, sex, time from trauma to treatment and complete or partial rupture but none were significant.

Discussion

The most important finding of the present study was that all patients were able to return to sports activities following surgical repair of acute proximal hamstring ruptures, most at the same level as before injury. Although the level of activity at the final follow-up was good according to the UCLA score [1] it was significantly lower on average than before the injury, and the Tegner score [23] was at the limit of significance. Most patients were satisfied or very

satisfied and the level of satisfaction was directly correlated with the postoperative level of activity.

All patients resumed their athletic activities a mean 5.7 months after surgery, with 79 % at the same level, which is comparable to results in the literature. Only 58 % of the patients returned to sports again after conservative treatment in the study by Sallay et al. [20]. In case of surgical treatment, this rate varies between 76 and 87 % [9, 18, 21] after an average of 5–6 months. In the present study 80 % of the athletes resumed sports at the same level. This rate was 74 % in the series by Sarimo et al. [22] and 87 % by Lempainen et al. [18]. In the present study 88.2 % of patients were "very satisfied" or "satisfied" which is also comparable to the rate in the literature.

The isokinetic tests showed that the average hamstring/quadriceps ratio was 54.7 ± 8.6 %. Birmingham et al. [2] found an average ratio of 56 % at 240° per second and Brucker and Imoff [3] 55 % (range, 44–66 %). Normal values range from 55 to 70 %.

The objective and subjective results of this series were comparable to those in literature. The difference in the scores before injury and at the final follow-up was probably due to a more detailed analysis and a more accurate definition of the level of activity based on the UCLA and Tegner scores.

In this series, there was no recurrent rupture at the final follow-up and none of the patients had sciatica or disabling pain. These complications are usually observed in chronic rupture [5, 10]. In the Sarimo et al. [22] study in a series of acute and chronic ruptures iterative rupture occurred in five patients (12.2 %).

Unlike with ultrasound, rupture was diagnosed in all patients on MRI. Thus ultrasound is not useful to diagnose this entity, and can also result in a delayed diagnosis.

This study also shows that this entity is not only a sports injury since hamstring rupture occurred in five patients after a slide in a domestic accident. Rugby was the most frequent sport, while for Wood et al. [24], it was the water-skiing but this was probably due to a recruitment bias.

The main strength of this study is the prospective design, with no lost to follow-up patients. Most published studies have been retrospective with a significant number of lost to follow-up patients. Furthermore, this is one of the largest studies to analyze acute ruptures alone. There were 2 cases of acute ruptures reported by Kwak et al. [15], 6/8 in the study by Bucker and Imoff [3], 9/23 in the study by Birmingham et al. [2], 14/41 in the series by Sarimo et al. [22] and 21/26 in that by Folsom and Larson [9].

This study had several limitations. First, there was no "conservative treatment" group because based on the results in the literature, this would have been unethical. This study did not identify any predictive factors for a postoperative return to the same level of activity. However, this is an ongoing prospective study and further results will be analyzed as the number of patients increases.

Conclusion

Surgical repair of acute proximal hamstring ruptures has significantly improved the functional prognosis of patients but it is still a serious condition that can compromise the patients future sports activities. It should be diagnosed and repaired as soon as possible to improve the chance of successful results.

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Conflict of interest None.

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