CASE REPORT

Muscle strength measurements and functional outcome of an untreated complete distal rectus femoris muscle tear

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SUMMARY

A 46-year-old man sustained an injury to his right thigh while skiing. He sought medical advice after 6 weeks, presenting a palpable painful mass of his anterior proximal thigh but no functional deficit. An isolated complete distal intrasubstance tear of the rectus femoris muscle was diagnosed on ultrasound and MRI scans, and the patient received no medical treatment.

Functional and dynamometer tests after 1 year showed high limb symmetry indexes and only slightly reduced values for peak torque and total work on the injured side. The patient had resumed skiing activities and reported slight pain after intense downhill skiing runs, but no functional limitations. MRI scans after 19 months showed increased retraction of the rectus femoris muscle. The natural history of an untreated complete distal rectus femoris muscle tear with no functional deficit may result in minimal disability.

but stopped intentionally to look up the hill, wondering what might have hit him. When he did not see anything out of the ordinary, he intended to keep skiing, but was not able to bear weight on his right leg. He then slowly skied down to the bottom of the course on his left ski only, and was able to drive home in his car with the use of cruise control.

The following weeks, he resumed light jogging and stretching exercises, but experienced limping, continued pain, swelling and an increasingly distinct palpable mass of his anterior proximal thigh. He felt that his activities were limited by pain and not a functional deficit. He sought medical advice 6 weeks after the incident.

INVESTIGATIONS

An ultrasound procedure was performed on 2 April showing a complete rupture of the rectus femoris muscle at the distal musculotendinous junction, with proximal retraction of the muscle belly and fluid at the rupture site. The patient was referred to the orthopaedic department at his local hospital, where the diagnosis was confirmed with a clinical examination followed by an MRI scan on 16 April (Intera 1.5 T; Philips Medical Systems, Best, the Netherlands). The sagittal T2-weighted images showed a retraction of the rectus femoris muscle and a hyperintense signal at the rupture site corresponding to the fluid observed during the ultrasound procedure (figure 1). The coronal PDW TSE SPIR images showed intramuscular oedema in the retracted muscle, fluid at the rupture site, and the non-injured muscle bellies of the vastus lateralis and medialis (figure 2).

The patient was examined again the following day at an orthopaedics and sports medicine centre by an experienced professor and specialist in orthopaedic surgery and sports medicine. There was no sign of functional deficits; the patient was able to extend his knee and flex his hip fully, and no muscle weakness was found during clinical examination.

TREATMENT

Since the clinical examination revealed no functional deficit or apparent muscle weakness, non-operative treatment was chosen. Although he was offered a training programme with a physical therapist at a sports medicine centre for athletes, the patient chose not to see a physical therapist, confident in his own cross-training habits.

BACKGROUND

The rectus femoris muscle is frequently involved in injuries to the knee extensor mechanism, most frequently presented as a quadriceps tendon rupture.^{1–3} Isolated injuries of the rectus femoris muscle are rare, and few cases of operative and non-operative treatment have been reported.^{4–5} The diagnosis is usually more elusive than in complete ruptures of the quadriceps tendon, where most patients are unable to extend their knee fully. It also differs from incomplete intrasubstance tears at the muscle-tendon junction.⁶ We describe the functional outcome after 1 year and MRI scans after 19 months of a patient with an untreated isolated complete distal intrasubstance tear of the rectus femoris muscle. To the best of our knowledge, this is the first presented case treated non-operatively that includes a follow-up with measurements of muscle strength and a functional score.

CASE PRESENTATION

The patient is a previously healthy 46-year-old man; a highly experienced, non-professional telemark downhill skier. Telemark skiing, also known as 'free heel skiing', is similar to alpine skiing, but with the boot fixed to the ski at the toe only.⁷ While steering through a left curve with weight-bearing almost solely on his right leg, knee flexed, the patient sustained an injury to his right thigh on 4 February 2012: In the middle of the curve, he suddenly felt intense pain in his anterior thigh, as though he had hit something. He did not fall over,

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Figure 1 The sagittal T2-weighted MRI image 10 weeks after the injury shows a retraction of the rectus femoris muscle and a hyperintense signal at the rupture site. After 19 months, further retraction is demonstrated, and absence of the fluid observed on the previous scan.

OUTCOME AND FOLLOW-UP

For the purpose of this case report, the patient accepted an invitation to a follow-up at 1 year (25 January 2013). To obtain quantitative data regarding the function of the knee after the rupture, concentric knee extensor and flexor muscle strength was measured at 60°/s with a Biodex 6000 isokinetic dynamometer (Biodex Medical Systems, Inc, Shirley, New York, USA; [figure 3](#)). The reason for conducting dynamometer tests was to compare the injured side with the non-injured side. The patient was happy to contribute his time and expected no specific benefit from these examinations other than quantitative data describing his muscle weakness, if any. The patient performed a warm-up on a stationary bicycle for 10 min prior to testing. Following a standardised procedure for isokinetic testing,⁸ he performed four practice repetitions, followed by 1 min rest, before five test repetitions at maximum effort were recorded. For knee extension strength, we found only slightly reduced values for peak torque and total work on the injured side compared to the uninjured side ([table 1](#)).

Following the isokinetic testing, four single-legged hop tests (the single hop test, the triple crossover test, the triple hop test and the 6 m timed hop test)⁹ were conducted in the described order ([figure 4](#)). The patient performed one practice trial before two test trials were recorded, and the uninjured leg was assessed first for all tests.¹⁰ The mean result of the two recorded trials is seen in [table 2](#).

The patient exhibited high limb symmetry indexes, although the crossover hop for distance indicated decreased hop ability on the injured side. Patient-reported functional status was assessed using the Lower Extremity Functional Scale (LEFS).¹¹ The patient scored a total of 96.3 of 100 points, reporting slight problems with jumping and recreational activities only. The patient had resumed skiing activities and reported slight pain after intense telemark downhill runs, but no functional limitations. He still presented a palpable mass of his anterior proximal thigh ([figure 5](#)).

The patient also accepted an invitation to an MRI scan after 19 months (30 August 2013). The sagittal T2-weighted images showed further retraction of the rectus femoris muscle, but absence of the hyperintense signal at the rupture site corresponding to the fluid observed on the previous scan ([figure 1](#)). The coronal PDW TSE SPIR images showed further retraction of the injured muscle, and absence of the intramuscular oedema and fluid observed on the previous scan ([figure 2](#)).

DISCUSSION

The rectus femoris muscle is more susceptible to injury than the remaining three quadriceps muscles, due to its superficial location, predominance of type II fibres, eccentric muscle action and extension across two joints.¹² The primary function of the rectus femoris muscle is to extend the knee, flex the hip and to provide stability of the pelvis on the femur in weight bearing.¹³

Figure 2 The coronal PDW TSE SPIR image 10 weeks after the injury shows intramuscular oedema in the retracted muscle, fluid at the rupture site, and the non-injured muscle bellies of the vastus lateralis and medialis. After 19 months, the image shows further retraction of the injured muscle, and absence of the intramuscular oedema and fluid.

Figure 3 The patient executing the dynamometer tests 1 year after injury.

Quadriceps muscle strains are common injuries, but isolated complete ruptures of the rectus femoris muscle are rare. Few cases have been reported.^{2 4 5 14} The diagnosis is usually more elusive than in complete ruptures of the quadriceps tendon, where most patients are unable to extend their knee fully. It also differs from incomplete intrasubstance tears at the muscle-tendon junction.⁶ To the best of our knowledge, this is the first presented case treated non-operatively that includes a follow-up with measurements of muscle strength and a functional score.

Surgical repair has been the recommended treatment for complete tears of the rectus femoris muscle,¹⁵ but no published functional results of such repairs are available. Some authors have presented satisfactory or even excellent functional results of non-operative treatment. One recent report by Weber *et al*⁵ describes a 42-year-old man triathlon athlete similar to the case

presented here, who returned to competitive sports. Hughes *et al*⁶ reviewed 10 athletes with intrasubstance tears of the rectus femoris muscle, all of whom experienced pain while running, with two cases requiring surgical intervention. Taylor *et al*⁴ reported a functionally successful repair of a rectus femoris rupture with the LARS (Ligament Augmentation & Reconstruction System, Corin Group plc, Cirencester, UK) synthetic ligament, following unsatisfactory results after 15 months of non-operative management.

In the case presented here, the patient experienced a minor functional deficit, with a measured muscle strength only slightly reduced compared with the non-injured side. This may be due to at least two mechanisms: first, functional overload of the injured muscle's synergists may have caused compensatory hypertrophy of the remaining quadriceps muscles;^{16 17} second, lateral force transmission through connective tissues within and surrounding the injured but neurologically intact rectus femoris muscle may contribute to the total force on the quadriceps tendon.¹⁸ Further studies involving biopsies of the remaining three quadriceps muscles may determine the degree of hypertrophy and biochemical changes of the muscle cells.

The recent 'Munich consensus statement' presents a new classification of muscle injuries in sport, stating that functional muscle disorders should be differentiated from structural injuries.¹⁹ The patient presented here represents an example of this important distinction. Although our patient presented with a severe structural injury in the form of a complete tear, a non-

Table 1 Results of dynamometer tests 1 year after injury

	Injured side	Non-injured side	Symmetry index (%)
Knee extension, peak torque (Nm)	273.3	298.2	91.6
Knee extension, total work (J)	1397.5	1469.7	95.1
Knee flexion, peak torque (Nm)	152.8	136.9	111.6
Knee flexion, total work (J)	829.2	780.6	106.2

Figure 4 Illustration of functional hop tests described by Noyes *et al.* Copyright 2011 SAGE Publications. Reprinted with permission.

Table 2 Results of single-legged hop tests 1 year after injury

	Injured side	Non-injured side	Symmetry index (%)
Single hop for distance (cm)	127.5	136.5	93.4
Crossover hop for distance (cm)	390.0	439.5	88.7
Triple hop for distance (cm)	461.5	455.5	101.3
6 m timed hop (s)	1.70	1.72	101.2

operative approach was chosen due to his lack of muscle weakness and absence of functional limitation. Individual assessment from case to case is important, since other cases with a similar structural injury may present with a functional loss. This is an important limitation of this case report. Patients with a similar structural injury, presenting with an absence of functional loss, may experience a functional loss greater than the patient presented here. Both cases presented with no functional deficit at the time of diagnosis; the triathlon athlete presented by Weber *et al.*⁵ did return to competitive sports and the patient presented in this report did return to recreational but intensive skiing. Although it is tempting to generalise that patients with similar or at least lower demand should experience the same clinical result, we do not know if this is true or not. We believe that operative treatment should always be considered in patients presenting with a functional loss at the time of diagnosis.

Non-operative treatment is a possible option for a complete distal rectus femoris muscle tear with no functional deficit.

Figure 5 The patient presenting a palpable mass of his anterior proximal thigh, 1 year after the injury.

Based on the results of this case study, it may be suggested that a rehabilitation programme, if needed, should include multidirectional plyometrics in addition to quadriceps strength training. However, the natural history of an untreated complete distal rectus femoris muscle tear with no functional deficit may result in minimal disability.

Patient's perspective

- ▶ My injury occurred on 4 February 2012. After a rather long period of strength exercises, I concluded this week with a day of Telemark skiing at Kongsberg ski center, Norway. It was a very cold day, -27°C , but I felt well dressed and warm. After approximately 6 h of skiing, I wanted to finish with one last run from the top, not holding back one bit, doing a maximum ski run. Half way down the slope, I experienced an intense pain in my right thigh, as if someone had kicked me very hard directly in the thigh. I stopped and looked up the hill, to see if there was something there that I may have hit. Seeing nothing of the sort, I manage to get to the bottom of the hill and to my car. I drove home, thinking this was a major strain injury to my muscles.
- ▶ After several weeks, there was no improvement, and I decided to see my doctor who sent me to an ultrasound examination. It turned out I had a complete rupture of one of the thigh muscles. After this, I was referred to the institution of the first author of this case report, where I got in contact with Dr Figved and subsequently several others with the proper knowledge of the injury. It was explained to me at the earliest stage, that this injury may be something I would have to live with, surgery or not. After the second opinion examination with the last author of this report, the conclusion is the same and surgery was not recommended. Just as important, I was comforted by the information I got from the doctors, that this injury should not affect my way of living or my training, and that I should be able to do Telemark skiing eventually. The follow-up at 1 year at the Norwegian Sports Medicine Institute with the second author of this report, has contributed in a big way to accepting the injury, and I now focus on how to progress and train the remaining muscles in my thigh.
- ▶ Since this is a type of injury that is not that common, I believe I have received the best possible follow-up. Hopefully, this has given the doctors some new knowledge of this kind of injury. At the moment, I have returned to doing structured training and exercises; 2 days of fitness training and 2 days of strength exercises per week, so I can be as prepared as I can be for skiing.

Learning points

- ▶ Isolated injuries of the rectus femoris muscle are rare, and the diagnosis is usually more elusive than in complete ruptures of the quadriceps tendon, which are more common.
- ▶ Patients may present with a palpable painful mass of the anterior proximal thigh, but not necessarily any functional deficit.
- ▶ MRI scans will confirm the diagnosis, showing retraction of the rectus femoris muscle but an intact quadriceps tendon.
- ▶ Non-operative treatment is a possible option for a complete distal rectus femoris muscle tear.

Contributors WF wrote the original manuscript and edited the final one, and examined the patient. HG conducted and interpreted the clinical tests, the dynamometer tests, examined the patient, edited the manuscript, and gave final approval. MA conducted and interpreted the MRI scans, edited the manuscript, and gave final approval. LE examined the patient, edited the manuscript and gave final approval.

Competing interests None.

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