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Proximal 1- and 2-Tendon Hamstring Avulsions: Overview and Surgical Technique

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Hamstring injuries are common, especially in athletes. They are particularly associated with sports that involve running and jumping, as well as rapid acceleration and deceleration. The spectrum of hamstring injuries spans from minor strains to partial tears to complete avulsions of 1, 2, or all 3 tendons. Severe hamstring injuries in which one or more tendons are completely torn or avulsed are typically characterized by a sudden onset of posterior thigh pain associated with localized tenderness in the upper thigh and some degree of loss of function. When a more serious injury than just a hamstring strain is suspected, magnetic resonance imaging should be done to confirm the diagnosis. Magnetic resonance image provides anatomical detailed information on the hamstrings and their pathology and it can be used to assess the amount of tendon retraction, which is an important feature for preoperative planning in proximal hamstring avulsions. In complete 1- or 2-tendon avulsions of the proximal hamstrings, surgical treatment should be considered the treatment of choice, at least in high level athletes. If, however, nonoperative treatment is chosen, surgery can be a useful option, also later should the conservative treatment fail. In this article, the indications of surgery in proximal 1- or 2-tendon hamstring avulsions are discussed, and the operative technique is presented.

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Hamstring injuries are common, especially in athletes, and represent a major cause of time lost from sports.¹ They are particularly associated with sports that involve running and jumping, as well as rapid acceleration and deceleration.² Hamstring injuries have been reported in various sports, such as sprinting and running, Australian football, track-and-field, soccer, and rugby.³⁻⁷ However, these injuries also occur frequently in the general population as people have increased their level of activity.

Most hamstring injuries are strains or minor tears which heal uneventfully. However, the spectrum of hamstring inju-

ries spans from these minor strains to partial tears to complete avulsions of 1, 2, or all 3 tendons. Strains typically occur at the musculotendinous junction.⁸ The more severe injuries that is avulsions of 1, 2, or all 3 tendons, typically occur at the bone tendon junction at the ischial tuberosity. Different combinations are possible and a single tendon may also be only partially torn or avulsed.⁹

Mechanism of Injury

Hamstring injuries are usually noncontact injuries.¹⁰ While running, the hamstring muscles become highly active in the later part of the swing phase when they work eccentrically to decelerate the swinging tibia and control extension of the knee: in this phase, the hamstrings develop tension while lengthening.^{11,12} After the swing phase, the hamstrings remain active into the initial stance phase, when they work concentrically as an active extensor of the hip joint.¹¹ It has been suggested that it is during this rapid changeover from eccentric to concentric function that the hamstrings are maximally activated and approaching peak length, and that they are most vulnerable to injury.¹³

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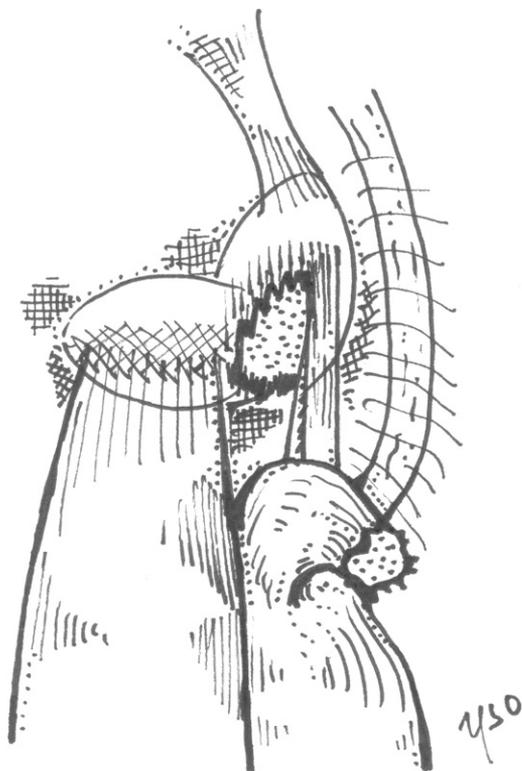


Figure 1 An isolated proximal biceps femoris avulsion of the right thigh.

In complete proximal hamstring avulsions, the typical injury mechanism is a rapid flexion of the hip with the ipsilateral knee in extension.¹⁴⁻¹⁷ This may occur while the patient falls, for example on a slippery surface, and 1 leg slips forward resulting in a sudden violent strain of the hamstring muscles. Sometimes in these cases, the result is a partial (1- or 2-tendon) avulsion of the proximal hamstrings. According to our experience, 1- or 2-tendon avulsions may and often do occur without the patient actually falling down but instead, for example, in sprinting or in rapid deceleration from sprinting. This injury mechanism resembles a similar mechanism for strains.

Classification

Hamstring muscle injuries represent a continuum of injuries ranging from minor damage of a few myofibers without loss of structural integrity to a complete hamstring muscle rupture with fiber disruption.² In the published data regarding hamstring injuries, an isolated semimembranosus or an isolated biceps femoris rupture is usually considered a partial tear because the whole hamstring muscle complex is not ruptured, whereas a complete tear would mean that all 3 hamstring muscles are avulsed.^{9,15,17,18} This terminology is somewhat confusing as the term partial could also mean that a single tendon is incompletely torn, which is also possible in hamstring tears. Therefore, a better way to classify these injuries could be to refer to them as 1-, 2-, or 3-tendon avulsions instead of partial or complete avulsions. In this propo-

sition, the term “partial” would refer to a single incompletely torn tendon. Two examples of different injury patterns, a 1-tendon avulsion and a 2-tendon avulsion, are depicted (Figs. 1 and 2).

Clinical Presentation

Severe hamstring injuries with one or more tendons completely torn or avulsed are typically characterized by a sudden onset of posterior thigh pain associated with localized tenderness in the upper thigh and some degree of loss of function. An audible pop is occasionally described, and immediate pain limits continuation of activity.² After the injury, there is often swelling and ecchymosis in the posterior thigh which often appears only after a few days and in the distal part of the thigh. In the early phase, the patient may have difficulty even in walking. A palpable defect is a common finding at the injury site, although, in the early phase, this may be masked by a hematoma.¹⁶ The defect is likely to be more obvious in 3 tendon avulsions than in 1 or 2 tendon avulsions. A retracted muscle bulge may be seen or palpated when the patient is asked to flex the knee against resistance. There may also be marked decrease in strength in knee flexion and in hip extension depending on the severity of the injury.

Patients with chronic proximal hamstring avulsions may describe feelings of tightness and weakness of the posterior thigh, as well as poor leg control, cramping of the hamstrings,

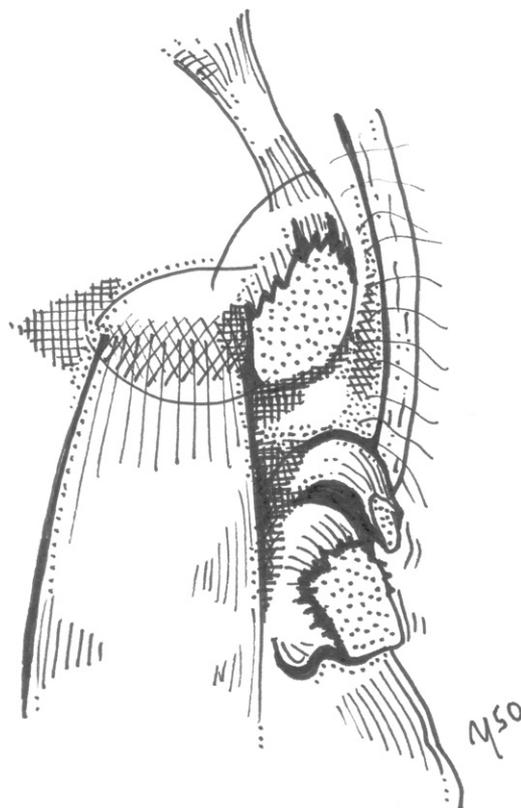


Figure 2 A combination injury with a proximal avulsion of the biceps femoris and the semimembranosus tendons of the right thigh.

and a sense of giving way of the affected extremity.^{9,17,19,20} Typically, running is either difficult or impossible.⁹ Sitting may aggravate the pain at the site of the ischial tuberosity. Sciatica-type of symptoms may also be present.^{9,15,19,21} Athletes are likely to have disturbing symptoms in activities. Of 28, a total of 18 competitive or professional athletes were not able to participate in sports at the preinjury level after a 1 or 2 tendon avulsions of the hamstrings, and also the remaining 10 athletes had difficulties while performing sports activities at their preinjury level.⁹

Injury-Related Complications

The proximity of the hamstring muscle group origin to the sciatic nerve can pose a special problem. Dysfunction of the sciatic nerve can be a result of adhesions in chronic injuries, whereas damage to the intramuscular nerve branches of the hamstring muscles can result from retraction of the muscles. The torn tendons may sometimes retract several centimetres, especially in 3 tendon avulsions. There are a few cases presented in the published data in which a proximal hamstring tear has caused sciatic nerve dysfunction.²²⁻²⁵ An unusual but severe complication of a proximal hamstring avulsion is an acute posterior thigh compartment syndrome.^{26,27}

Diagnostic Imaging

When an injury more serious than just a hamstring strain is suspected, a magnetic resonance imaging (MRI) should be done to confirm the diagnosis. MRI provides detailed anatomical information on the hamstrings and their pathology, and it can be used to assess the amount of tendon retraction, which is an important feature for preoperative planning in proximal hamstring avulsions.^{28,29}

MRI has been shown to be more accurate than ultrasound in detecting proximal hamstring tears.³⁰ Plain radiographs are usually unnecessary when evaluating hamstring injuries. They may be used to detect a proximal avulsion fractures^{31,32}; however, a bone fragment may also be x-ray negative, especially in children.³³ In adults, bony avulsions of the ischial tuberosity are extremely rare.

Treatment

There are only few clinical studies concerning conservative treatment of hamstring muscle injuries or of human skeletal muscle injuries in all.³⁴ Therefore, the scientific evidence of conservative treatment of proximal hamstring avulsions is almost nonexistent.

Sallay et al¹⁵ have published a series with 6 patients with proximal 1- or 2-tendon tears, and these patients were treated nonoperatively. It was reported that these patients were able to return to their preinjury sports, however, at a lower level, and that the patients reported of minor limitations.

In a series of 47 athletes with proximal 1- or 2-tendon hamstring avulsions eventually treated surgically, 42 of them had initially been treated conservatively.⁹ The average delay

from injury to surgery in the series was 13 months. After this period, none of the athletes were satisfied with result and therefore surgery was indicated.

In several other studies,^{20,35-38} it has been shown that even 1- and 2-tendon tears may lead to significant functional deficit if left untreated, especially in athletes. These studies have also shown that there are different combinations proximal 1- or 2-tendon hamstring tears.

It is possible that some proximal 1- or 2-tendon avulsions may go undiagnosed and the patients might be able to return to preinjury level of activity, especially if the activity level is low. Further studies are needed to evaluate in which cases nonsurgical treatment might be indicated in proximal 1 or 2-tendon hamstring avulsions.

The indications of surgical treatment in proximal 1- or 2-tendon avulsions of the hamstrings are not clear. A common guideline regarding proximal hamstring injuries has been that only in the presence of a complete (3-tendon) rupture of the proximal attachment of the musculotendinous complex should surgical repair be considered.^{2,13,39,40} However, more aggressive recommendations have recently been proposed. Folsom and Larson²⁰ suggested that a pure isolated conjoint tendon (the biceps femoris and the semitendinosus) avulsion should be surgically repaired in active patients. Cohen and Bradley⁴¹ suggested that surgical treatment should be advocated if 2 out of 3 hamstring tendons are ruptured from the ischial tuberosity. Regauer et al⁴² recommended early operative treatment also for an isolated proximal semimembranosus rupture.

In complete 3-tendon proximal avulsions of the hamstrings, early surgery has been shown to produce better results when compared with late surgery.¹⁷ Whether this applies also to 1- or 2-tendon tears is not known. In the study by Lempainen et al,⁹ the average delay from injury to surgery in patients with a 1- or 2-tendon avulsion was 13 months, and yet 42 of 47 patients were rated as having an excellent or good result. At the same time, it is known that fatty degeneration occurs in chronic hamstring muscle tears.¹⁵ Also, restoration of the anatomy is considerably easier when surgery is performed in the acute phase. Our recommendation is that, at least in high level athletes, early surgery be considered in both 1- and 2-tendon avulsions, as it is very likely that the injury will cause considerable problems in athletic activities and the results of surgery seem to be good in most cases.

Operative Procedure

In surgery, either spinal or general anesthesia may be used. The patient is placed in the prone position and the affected leg should be draped to allow free movement. The knee may be kept in 30° of flexion to release tension in the hamstrings. A vertical skin incision should be used especially when there is retraction of the muscles as they may need to be mobilized to achieve tension-free contact to the ischial tuberosity. The incision starts at the ischial tuberosity extending distally, approximately 10-15 cm. A fasciotomy is done and continued distally, approximately 15 cm from the origin of the hamstring muscles. The lower edge of the gluteus maximus mus-

cle is freed and careful hemostasis should be performed. The posterior cutaneous femoral nerve should be identified and spared. This is not always easy, especially in the chronic cases. The ischial tuberosity can be exposed by retracting superiorly the inferior border of the gluteus maximus muscle. The sciatic nerve can be found lateral to the ischial tuberosity and it should be freed from adhesions in chronic cases, especially if there are sciatica type of symptoms. In the absence of nerve-related symptoms, exploration of the sciatic nerve is not necessary.

In most cases, re-attachment of the torn tendons has been done using suture anchors.^{9,16,17,37} When surgery is performed in the early phase, anatomical reattachment can be done. In chronic cases, the torn tendons can be reattached slightly distal and medial to the original site of the ischial tuberosity to avoid tension.

Postoperative Protocol

Postoperatively, usually no immobilization with casts or orthoses is necessary.⁹ The patients are allowed to begin partial weight-bearing within 2 weeks from the operation and full weight-bearing 2-4 weeks after surgery. Sitting is avoided for the first 2 postoperative weeks. Swimming and water training can usually be gradually begun 2-3 weeks after surgery, and isometric muscle exercises and bicycling with gradually increasing time and intensity at 4-6 weeks from the surgery. Weight training can be started 2 months and running 2-4 months after surgery.

Results of Surgical Treatment

There are only few published cases dealing with surgical treatment of proximal 1- or 2-tendon hamstring tears because most series deal with 3-tendon avulsions in which only a few cases with 1- or 2-tendon tears have been included.^{20,35-38,41,42} In many of these studies, a more active treatment approach has been recommended also for proximal 1- and 2-tendon hamstring tears, especially in athletes.^{20,38,41,42} The main reason for this more active approach might be the increased experience in treating these injuries.

In a series of 47 athletes with proximal 1- or 2-tendon hamstring avulsions, 41 were reported to have an excellent or good result and 41 patients were able to return to their pre-injury level of sports.⁹ Of these patients, 13 were professional and 15 other competitive level athletes.

The return to unrestricted sports activities should depend on hip range of motion, muscle strength, and sport-specific agility requirements. Return to sports and other strenuous physical activity can usually be expected at an average of 5 months after surgery, although for some patients it took a maximum of 12 months.⁹ It should be remembered, however that a proximal 1- or 2-tendon avulsion can be a career-ending injury for an athlete.⁹

Complications of Surgical Treatment

Commonly known complications related to any surgical procedure, especially in the lower extremity, include wound infection, postoperative hematoma or seroma, and deep venous thrombosis.^{9,17} The posterior cutaneous femoral nerve poses a specific risk with surgical treatment of these particular injuries. Injury to the nerve can cause symptoms, such as neuralgia, hyperesthesia, and sensory loss in the posterior thigh, but these symptoms may resolve with time, which might suggest mere intraoperative traction of the nerve.¹⁷

Conclusions

Complete proximal 1- or 2-tendon avulsions of the hamstrings are unusual, but they may be under-diagnosed. High level of suspicion based on patient history and clinical examination is necessary. When suspected, MRI should be used to assist in the diagnosis. The exact diagnosis of what particular tendons have been torn is not always easy in MRI or even in surgery.

Most of the patients with proximal 1- or 2-tendon avulsions seem to be active athletes or at least they are the ones who have the most troublesome symptoms and seek help. In incomplete avulsions, the initial treatment should be nonoperative. However, in complete 1- or 2-tendon avulsions, surgical treatment may be considered the treatment of choice at least in high level athletes. If nonoperative treatment is chosen, surgery can be performed at a later time should the conservative treatment fail.

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