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Proximal Hamstring Tendinopathy

Results of Surgical Management and Histopathologic Findings

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Background: Tendon disorders are common problems in sports and are known to be difficult to treat. Only limited information is available concerning treatment of proximal hamstring tendinopathy. To the authors' knowledge, no histopathologic findings of proximal hamstring tendinosis have been published.

Hypothesis: Surgery (semimembranosus tenotomy and exploration of the sciatic nerve) is an effective treatment for proximal hamstring tendinopathy.

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

Methods: A total of 103 cases of proximal hamstring tendinopathy in athletes (58 men, 32 women; 13 bilateral operations) with surgical treatment were included. The cases were retrospectively analyzed, and a 4-category rating system was used to evaluate the overall result. At the follow-up, the patients were asked about possible symptoms and their return to sports. Biopsy samples from 15 of the operated tendons were taken and analyzed by a pathologist.

Results: The average follow-up was 49 months (range, 12-156 months). The result was evaluated to be excellent in 62 cases, good in 30, fair in 5, and poor in 6. After surgery, 80 of the 90 patients were able to return to the same level of sporting activity as before the onset of the symptoms. This took a mean of 5 months (range, 2-12 months). Typical morphologic findings of tendinosis were found in all biopsy specimens.

Conclusion: Given the good functional outcome and low complication rate, the authors present surgical treatment as a valuable option in proximal hamstring tendinopathy if conservative treatment fails.

Keywords: hamstring; histopathology; tendinosis; tendinopathy; surgical treatment

Tendon injuries and other tendon disorders are among the most common problems in sports.[12] They are known to be difficult to treat and often result in considerable morbidity and impaired athletic performance.[31,37] In the lower extremity, tendinopathy typically involves the patellar and Achilles tendons.[36] The primary treatment is nonsurgical, but if conservative therapy fails, surgical treatment can be effective.[1,28,29,31,34] Chronic tendon problems concerning patellar and Achilles tendons are under continuous research, but only limited information exists on proximal hamstring tendon disorders.[1,10,31]

Proximal hamstring tendinopathy, previously reported under the name of hamstring syndrome,[20,23,33] is supposedly an overuse injury that expresses itself by lower gluteal pain, especially during sports.[10] It has been seen in athletes of various sports activities, but especially in sprinters and middle- and long-distance runners.[10,20,33]

The main purpose of this clinical study was to evaluate the follow-up results of surgically treated proximal hamstring tendinopathy. Typical histopathologic findings and surgical technique are also presented.

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TABLE 1
Sports Activities of the 52 Professional and Competitive-Level Athletes With a Proximal Hamstring Tendinopathy

Activity	Professional Athletes	Competitive-Level Athletes
Long-distance running	3	13
Soccer	1	9
Middle-distance running	–	5
Heptathlon, decathlon	–	3
Ice hockey	–	3
Finnish baseball	–	2
Long jump	–	2
Power lifting	–	2
Triathlon	1	–
Aerobics	–	1
Ballet	–	1
Cross-country skiing	–	1
Floorball	–	1
Handball	–	1
Orienteering	–	1
Tennis	–	1
Triple jump	–	1
Total	5	47

PATIENTS AND METHODS

Between 1991 and 2005, 105 patients (101 athletes, 4 non-athletes) were surgically treated at our hospital because of proximal hamstring tendinopathy. The cases were retrospectively analyzed and 11 patients with insufficient follow-up time and/or lacking information were excluded, as well as the 4 patients not actively involved in sports. This left 90 athletes (58 men, 32 women) with at least 12-month follow-up for this study. The average age of the patients at the time of operation was 34 years (range, 16-63 years). The left side was involved in 44 patients and the right in 33 patients. Thirteen patients had bilateral proximal hamstring tendinopathy. In 8 of those 13 patients, both sides were operated in the same session and in 5, the left and right sides were operated at different times. The total number of cases analyzed was thus 103. Additionally, during the follow-up, a reoperation was needed in 6 patients.

All patients included in our study were actively involved in sports. There were 5 professional athletes, 47 competitive level athletes, and 38 recreational athletes. The average age of the professional and competitive level athletes was 26 years and that of the recreational athletes, 45 years. The most common sports among professional and competitive level athletes were long- and middle-distance running and soccer (Table 1). Recreational athletes were typically involved in various endurance sports, most often in long-distance running, orienteering, and cross-country skiing.

All patients reported pain in the lower gluteal region during sports activities, especially during running with a faster pace or sprinting, and most of them also suffered from pain at the site of the ischial tuberosity while sitting for a prolonged time (eg, while driving a car). A few patients reported occasional radiating pain from the ischial tuberosity to the midthigh during running. However, no symptoms to the level of the knee or distal to it were reported. In most of the patients, the pain had appeared and increased gradually without any acute event. However, 17 patients reported that the initial onset of pain was after sudden mild injury to the posterior thigh (muscle strain or overstretching). In all cases, continued exercises and stretching of the posterior thigh had made the situation gradually worse.

On clinical examination, active stretching of the hamstring muscles resulted in pain at the site of the ischial tuberosity. No remarkable weakness in knee flexion or in hip extension was noted in manual tests in any of the cases. No abnormalities were found in neurologic tests, such as Lasègue sign and reflex testing.

The preoperative diagnosis was based on history, clinical examination, and diagnostic imaging. Magnetic resonance imaging was routinely performed preoperatively in all cases (Figure 1). Additional radiographs, electroneuromyographic (ENMG) studies, and MRI of the lumbar spine were done as necessary to rule out other causes of the symptoms.

All patients were, or had initially been, treated conservatively with modified or complete rest from sporting activity, stretching of the hamstrings, medication (nonsteroidal anti-inflammatory drugs, corticosteroid injections), and physiotherapy. The indications for surgical treatment were chronic, disturbing symptoms despite conservative treatment and typical clinical and typical MRI findings of proximal hamstring tendinopathy.

The time period from the onset of symptoms to surgery was, on average, 21 months (range, 4 months to 10 years; median, 14 months). In 3 cases, symptoms had lasted less than 6 months before the operation was done. In 2 of those 3 cases, symptoms were so severe that there were no reasons to postpone the operation. One patient wanted to be operated after 4 months from the onset of symptoms because she had the other side operated before with success.

Surgery was performed under spinal anesthesia and the patient in the prone position, either via a transverse gluteal crease incision or via a longitudinal posterior incision starting from the ischial tuberosity extending approximately 7 to 10 cm distally. The lower edge of the gluteus maximus muscle was freed, the posterior cutaneous femoral nerve was identified and spared, and the ischial tuberosity was exposed by retracting superiorly the inferior border of the gluteus maximus muscle. The proximal attachment sites of the hamstring muscles were identified and a transverse tenotomy was done to the thickened semimembranosus tendon 3 to 4 cm distal to the origin. The biceps femoris and semitendinosus muscles were left intact. The tenotomized semimembranosus tendon was then sutured securely to the biceps femoris tendon to prevent excessive retraction. After tenotomy, the sciatic nerve was explored and, in some cases in which there were minor adhesions around it, the adhesions were freed. In no cases was an actual meticulous neurolysis necessary. The procedure is presented in schematic drawings of the right proximal hamstring muscle insertion (Figures 2-5). No signs of hamstring ruptures, partial or complete, were seen in these operations.

To investigate typical histopathologic findings, biopsy samples from 15 consecutive semimembranosus tendons were taken from the tenotomy site during surgery. One

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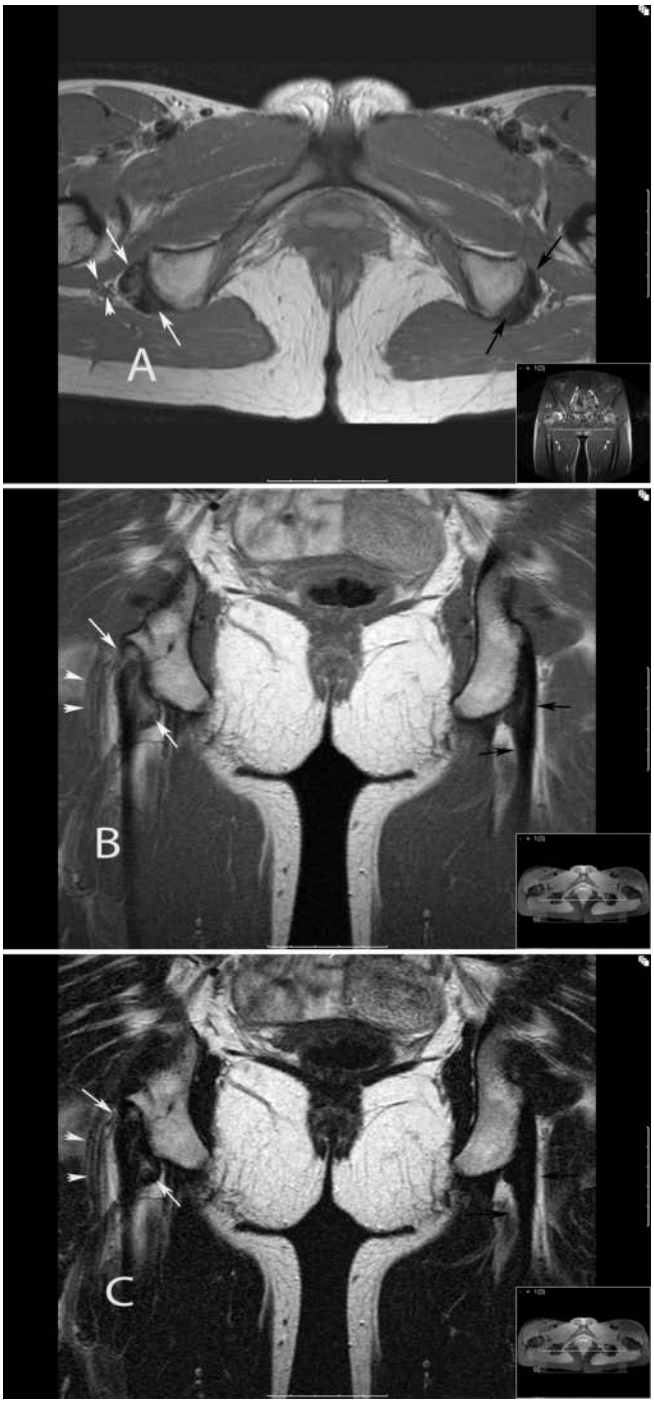

Figure 1. Magnetic resonance images of a 21-year-old female endurance runner with chronic posterior right thigh pain. Proton density–weighted (repetition time [TR]/echo time [TE] 3207/15) axial (A) and coronal (B) (TR/TE 3779/11) images and T2-weighted (TR/TE 3779/100) coronal image (C) at common hamstring insertion level. Signal characteristics on the right symptomatic anterior common hamstring insertion (white arrows), corresponding to the semimembranosus tendon, show tendinosis and no tear. Immediately lateral to the tendon runs normal right sciatic nerve, surrounded by normal bright fat (white arrowheads). The normal left tendon insertion is indicated with black arrows.

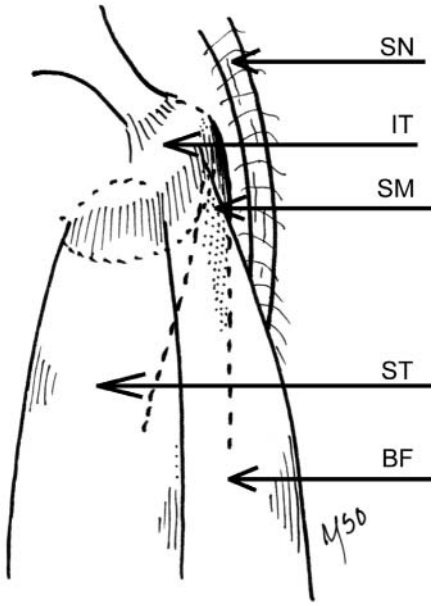

Figure 2. Preoperative view of the right hamstring muscle insertion. The semimembranosus muscle (SM) is related anteriorly to the biceps femoris muscle (BF). The sciatic nerve (SN) curves beneath the hamstring muscles from the lateral side of ischial tuberosity (IT). The semitendinosus muscle (ST) is medial to the biceps femoris muscle.

biopsy sample from a normal hamstring tendon was taken from an 18-year-old athlete with an operatively treated ischial tuberosity avulsion fracture for a control sample.

The biopsy specimens were fresh-frozen in isopentane, cooled with liquid nitrogen. Frozen samples were stored at –70°C until further processed. The frozen samples were longitudinally cut to 5 μm sections and stained with Herovici's method for routine morphologic analyses, Alcian blue staining to demonstrate excess of mucin between the collagen fibers, and CD45 (Ventana Medical Systems, Tucson, Arizona) immunohistochemical staining to detect inflammatory cells.

Postoperatively, an elastic bandage was used for 1 to 2 weeks. The patients were allowed to begin full weightbearing gradually during the first 2 postoperative weeks. Swimming and water training were allowed 2 to 3 weeks after surgery. Isometric muscle exercises and bicycling with gradually increasing time and intensity were begun after 4 weeks. Running and heavier weight training were allowed 2 months after the operation, and return to full athletic activity was allowed after 2 to 4 months.

Patients were followed postoperatively at our outpatient clinic. Follow-ups were arranged monthly up to 3 to 4 months and then at 6 and 12 months postoperatively. Additional visits were scheduled for study purposes. During the follow-up, patients underwent functional evaluations by an orthopaedic surgeon. Clinical examination included assessment of the range of motion of the hip joint and strength in knee flexion and in hip extension. For subjective evaluation, the patients were asked about possible symptoms (pain, stiffness,

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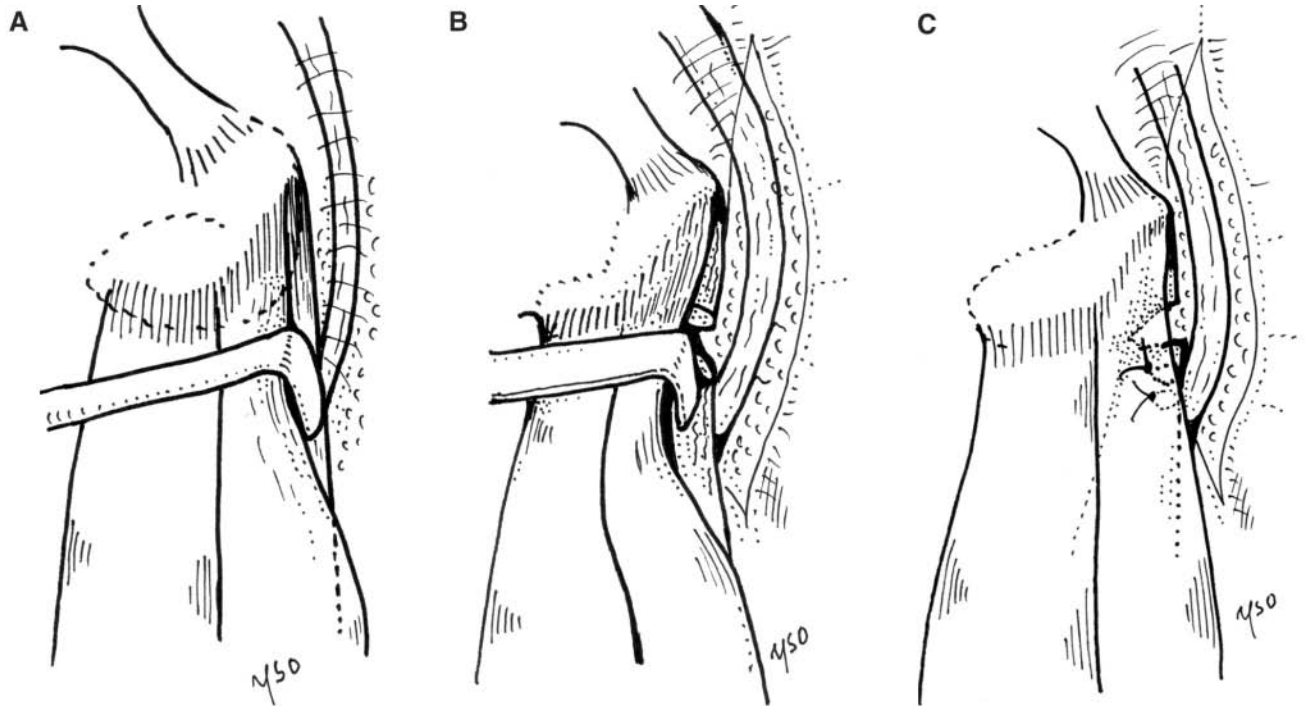

Figure 3. A, the lateral edge of the biceps femoris muscle is pulled medially to expose the thickened semimembranosus tendon. B, tenotomy is done to the tendinous part of the semimembranosus muscle. The sciatic nerve is explored. C, the distal head of the tenotomized semimembranosus tendon is sutured to the biceps femoris tendon.

weakness, etc) of the operated thigh. Also, the patients' ability to return to sports was evaluated.

The result of surgery was graded as excellent, good, fair, or poor. The result was classified as excellent if the patient was asymptomatic and able to return to the same level of sporting activity as before the onset of the symptoms. If there were occasional minor symptoms during strenuous sports activity, but the former level of sports had been achieved, the result was classified as good. The result was fair if symptoms did not allow return to the previous level of sport and thus dictated cessation of competitive sports activities or mandated a change in the form of the recreational sport activity. Finally, the result was classified as poor if the patient had given up all sports activities and had occasional disturbing symptoms, even in activities of daily living. Also, if a reoperation was necessary, the result was graded as poor.

The study protocol was approved by the local hospital ethics committee.

RESULTS

The mean length of the follow-up was 49 months (range, 12-156 months; median, 48). In 10 cases, the follow-up was less than 2 years. The result was evaluated to be excellent in 62, good in 30, fair in 5, and poor in 6 cases (Table 2). Of the 90 patients, 80 (89%) had an excellent or good result and were able to return to the same level of sporting activity as before the onset of the symptoms after the first operation. This took a mean of 5 months (range, 2-12 months; median, 5). Additionally, 4 patients were able to return to their previous level of sports after a reoperation.

In 4 athletes (2 competitive level and 2 recreational), the result was rated as fair. These 2 competitive-level athletes had to finish their competitive sporting careers but they were still able to participate in recreational sports. All 4 of these patients still suffered from pain and tightness of the operated thigh in intense sports activities.

Four other athletes (2 competitive level and 2 recreational) with results rated as poor underwent second-look operations because of early residual symptoms (<12 months) after the first operation. Their final result was graded as poor because a reoperation was needed. In all 4 reoperations, there were tight adhesions and scar tissue around the hamstring origin and the sciatic nerve. After the second operation, in which scar tissue was removed and the sciatic nerve re-explored, they all improved subjectively and the 2 competitive-level athletes were able to continue their athletic careers. Two other patients (1 competitive level and 1 recreational long-distance runner) needed a reoperation during the follow-up. They were both initially asymptomatic after the first operation. However, after 2 years the symptoms recurred and a reoperation was required. In the second operation, a new tenotomy was done to the tight regenerated semimembranosus tendon. Their final results were graded poor because a reoperation was necessary, even though they were both able to continue their sporting careers.

Complications

Postoperatively, 1 of the 90 patients suffered from a deep venous thrombosis in the lower extremity that was treated with oral anticoagulants. Two patients had hyperesthesia of the incision area, but the symptoms resolved during the

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follow-up. One wound fistula was treated by excision in local anesthesia.

Histologic Evaluation

Histologically, the control biopsy specimen showed no signs of tendinosis. In contrast, various degrees of tendinosis were evident in all other biopsy specimens. No inflammatory cells were seen in any of the samples that were verified by negative CD45 immunostaining. The typical morphologic findings of tendinosis (ie, rounding of tenocyte nuclei, increased ground substance, collagen disintegration, and increased vascular proliferation) were seen in various degrees (Figure 4). No calcification or fibrocartilaginous or bony metaplasia was seen in any of the samples. Signs of tendon rupture were likewise not seen in any of the samples. However, some fat cells were seen in all samples, including the control. In the control tendon, the fat cells were located outside the tendon, but in the tendinosis samples, there seemed to be isolated fat cells between the collagen bundles, suggesting fatty degeneration.

Imaging and ENMG Findings

In preoperative MRI, a thickened semimembranosus tendon was seen in all cases, with increased signal intensity on T1-weighted and proton density images without bright signal tear on T2-weighted images. In some cases, minor involvement of the biceps femoris tendon was also detected. Radiographs and ENMG findings were normal.

DISCUSSION

The terminology used previously in the literature concerning chronic tendon disorders has been confusing. Maffulli et al[18] stated that terms such as tendinosis, paratendinitis, and tendinitis should be reserved only for cases where the histopathology was verified by tendon biopsies. Furthermore, it was suggested that a combination of pain, swelling, and impaired performance should be labeled tendinopathy, and it should also include the histopathologic entities tendinosis and peritendinitis.[18] Nowadays in the literature, the term tendinopathy has been commonly used in chronic patellar and Achilles tendon disorders.[1,27,29,31,36] On the basis of this and to standardize nomenclature, we have used the term proximal hamstring tendinopathy instead of proximal hamstring tendinosis. We have also abandoned the previously used term "hamstring syndrome"[20,23,33] because it was somewhat obscure.

The causes and pathophysiology of tendinopathy in humans have not been scientifically proven, but it has been proposed that the tendon's failed healing response to repetitive stretch and mechanical overload may be associated with the development of tendinosis.[40] This theory does make sense in proximal hamstring tendinopathy. First, hamstring muscles are under repetitive stretching, for example while running. Second, in most of our patients, the pain in the proximal posterior thigh had appeared and increased gradually, and in all cases continued exercises made the situation worse.

TABLE 2
Results of Surgical Treatment in 103 Cases of Proximal Hamstring Tendinopathy

Group	Excellent	Good	Fair	Poor
Professional athletes	6	–	–	–
Competitive-level athletes	29	15	3	3
Recreational athletes	27	15	2	3
Total	62	30	5	6

Based on previously published studies and our experience, sciatic nerve irritation may occasionally be related to proximal hamstring tendinopathy.[20,23,33] This irritation of the sciatic nerve may aggravate the pain caused by hamstring tendinopathy alone.[33] The mechanism for sciatic nerve irritation might be that repetitive stretch and continuous overload of the proximal hamstring tendons cause scarring and adhesions around the nerve. It is also possible that radiating pain occasionally felt, especially during the forward swing phase of running, could be caused by impingement of the sciatic nerve because of swollen and thickened tendon insertion on the lateral part of the ischial tuberosity.[20] However, it is difficult to differentiate pain originating from the tendon from pain originating from nerve involvement.

The surgical procedure used in this study is modified from the earlier technique described first by Puranen and Orava[33] in 1988. In previously published studies, surgical procedures have focused on the "tendon-like thickened band" on the anterolateral side of the biceps femoris muscle.[20,23,33] Now, after better diagnostic tools and even more accurate knowledge of the anatomy of the proximal hamstring origin, it is obvious that this "thickened band" is actually the lateral border of the semimembranosus tendon, which is typically seen thickened in proximal hamstring tendinopathy.[21,42]

We have used the semimembranosus tenotomy in treating these patients because the semimembranosus tendon is the one most affected in proximal hamstring tendinopathy. The clinical success observed after operative release of the semimembranosus tendon may be based on the same stress-shielding theory as seen in adductor tendinopathy.[25] It might also be that in proximal hamstring tendinopathy, tenotomy of the semimembranosus tendon transfers stress from the semimembranosus tendon to the biceps femoris and to the semitendinosus muscles. This stress-shielding may assist the semimembranosus tendon to recover.

In proximal hamstring tendinopathy requiring surgical treatment, it is not clear why the semimembranosus tendon is affected more often than the other tendons. Recently, Askling et al[3-5] have found that in proximal hamstring injuries, isolated proximal semimembranosus tendon injuries often need a more prolonged recovery time than proximal biceps femoris injuries and may even threaten the career of an athlete. This might reflect a better overall healing capacity of the biceps femoris tendon compared to the semimembranosus tendon.

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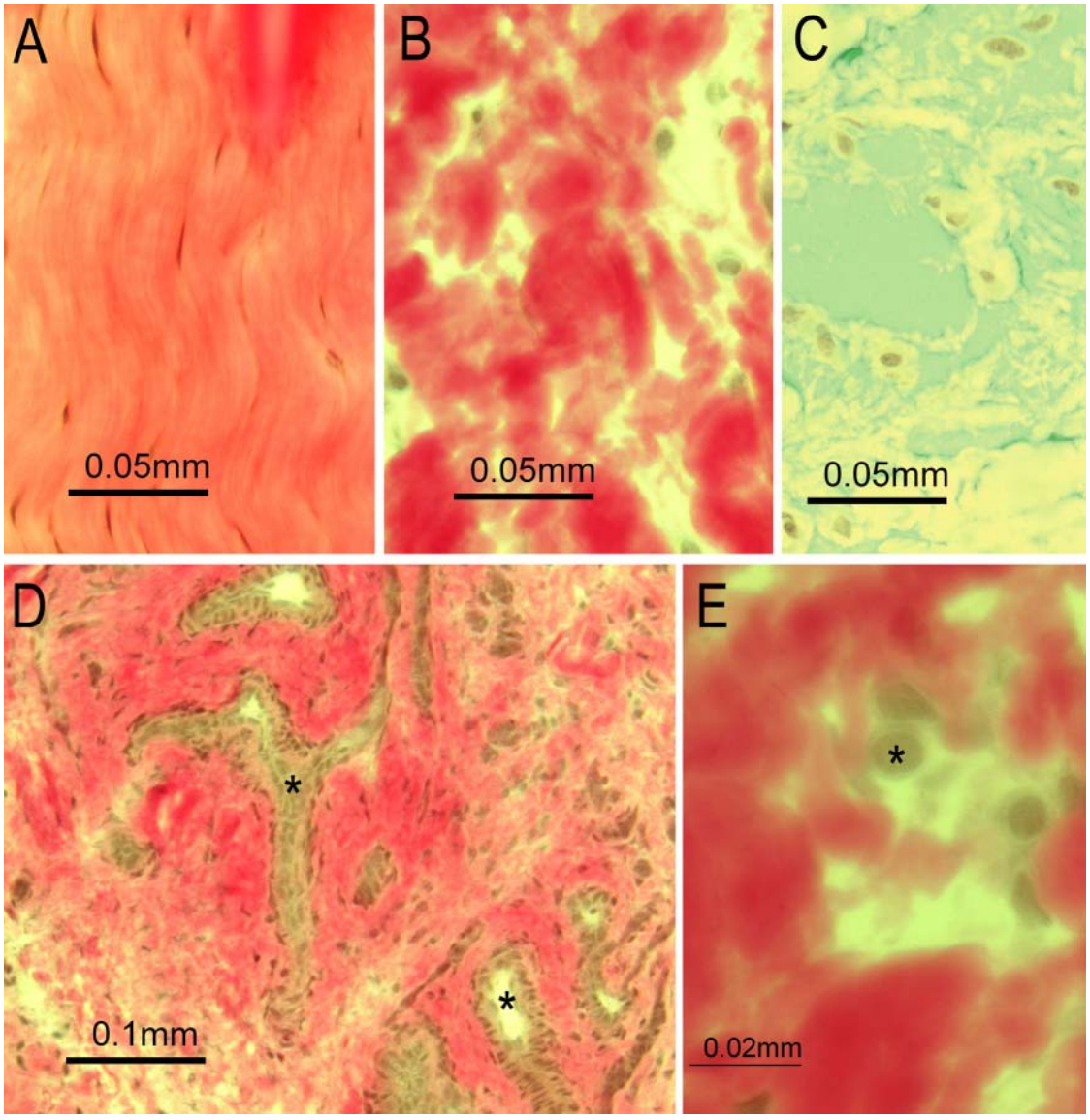

Figure 4. Typical morphologic findings in tendinosis. A, normal hamstring tendon with spindle-shaped nuclei of the tenocytes and dense, well-oriented collagen fibers. B, disintegration of collagen fibers. C, increased mucin ground substance seen as bluish material demonstrated by Alcian blue staining. D, capillary proliferation. Two capillaries are marked with asterisks. E, rounding of the tenocyte nuclei and increased cytoplasm. One tenocyte is marked with an asterisk. Herovici and Alcian blue stainings.

Because of the complex anatomy, chronic pain in the gluteal region and in the posterior thigh is often a diagnostic challenge. The main differential diagnoses are piriformis syndrome,[30] stress fractures,[19] apophysitis,[16] avulsion fractures,[16] bursitis,[35,39] posterior femoral compartment syndrome,[24] and partial proximal hamstring tears.[17] Lumbar radicular pain and other causes for sciatic pain such as soft tissue tumors should also be remembered and excluded.[6,8,32]

We have used MRI routinely to confirm the diagnosis of proximal hamstring tendinopathy and to help rule out other causes of pain. Magnetic resonance imaging provides detailed anatomic information of tendons and tendon pathologic changes. It is sensitive in depicting causes for symptoms related to the hamstring tendons and muscles.[7,9] Typical MRI findings of proximal hamstring tendinosis include increased tendon girth and intrasubstance signal heterogeneity.[7,9,15] Asymmetric involvement of hamstring tendons is a common finding in unilateral cases.[7] Reactive edema of the ischial tuberosity and even cortical defects may occasionally be noted.[7] The location of the sciatic nerve close to the proximal hamstring tendons is clearly depicted on magnetic resonance images.[7,9] In proximal hamstring tendinopathy, the thickened tendon insertion lateral to the ischial tuberosity can occasionally cause even direct compression of the sciatic nerve.[9] The pain can also result from adhesions and fibrosis surrounding the sciatic nerve.[9] Occasionally the sciatic nerve

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can be seen markedly thickened and edematous on magnetic resonance images, which may explain patients' neuropathic symptoms.[7] In our study, thickening of a tendon with increased signal intensity on T1-weighted and proton density images without bright signal tear on T2-weighted images was regarded as a diagnostic finding for tendinosis. The tendons were carefully compared with those on the contralateral side. However, one must keep in mind that bilateral hamstring tendon involvement is not rare in athletes.

Radiographs and ENMG examinations were also used in some cases. Radiographs may show apophysitis and avulsion fractures of the ischial tuberosity, stress fractures, and possible bone tumors.[16,19] Also an ENMG study can be a valuable asset in the differential diagnostics, for example in detecting symptoms originating from the lumbar spine. However, in proximal hamstring tendinopathy, ENMG studies are typically normal.[33] In our series, there were some patients who reported a radiating pain from the ischial tuberosity to the midthigh. In all of them, the ENMG studies were normal. Whether the radiating pain described by these patients originates from the sciatic nerve or the hamstring muscles is not known.

In this study, we analyzed biopsy specimens taken from the affected tendons in the 15 consecutive hamstring tendinosis patients. Even though a biopsy specimen was not taken in all of the cases, and thus no definite conclusions can be made, it seems that the morphologic changes in hamstring tendinosis are largely identical to those previously described in Achilles and patellar tendinosis.[11,27] In all samples, signs of degenerative processes of various severity were detected without signs of inflammatory cells.

Previous studies have shown that satisfactory results can often be expected after surgical treatment of proximal hamstring tendinopathy, even after failed conservative therapy.[20,23,33] To our knowledge, no results of conservative treatment concerning proximal hamstring tendinopathy have been published except for 1 case report presented in a review study by Fredericson et al.[10] In our study, all patients were initially treated nonoperatively. However, because many of the patients were referred from other centers after failed conservative treatment and because the treatment protocols were inconsistent, it is impossible to draw any conclusions concerning the usefulness of different conservative treatment strategies.

The role of local corticosteroid injections in the treatment of chronic tendon disorders is controversial.[26] In proximal hamstring tendinopathy, we have used peritendinous injections of corticosteroids in the early phase of symptoms. They seem to give good short-term results in pain relief in many cases, but often the symptoms recur later.

According to our experience, the symptoms in proximal hamstring tendinopathy have a tendency to become chronic. In our study, the delay from the initial onset of symptoms to surgery was an average of 21 months. The reasons for the long delay were often difficulties in making the correct diagnosis or poor awareness of the treatment alternatives for proximal hamstring tendinopathy.

Koulouris and Connell[14] evaluated the MRI findings after acute hamstring injuries. They noted that there were imaging features of preexisting hamstring enthesopathy in 3 of 5 patients with an acute partial tear of the hamstring muscles. It seems that pathologic changes in proximal hamstring tendons may expose the muscles to partial and complete ruptures, at least in some cases. This finding has been shown also in several other tendon ruptures.[13] In our present study, no partial or complete tears were seen at surgery and in the 15 biopsies there were no signs of tears either. Whether the tendinopathy operation prevents possible future hamstring tears remains still unclear. During the follow-up in this study, no partial or complete proximal hamstring tears were diagnosed in the operated patients.

This study had certain limitations. Because of the retrospective nature, results after surgery were evaluated by the ability of the patient to return to sports and by assessing subjective symptoms of each patient. No actual measurements were made and no validated scores were used. Furthermore, we were unable to include a group of nonsurgically treated matched controls. In the future, a randomized controlled trial with standardized outcome measures and long-term follow-up is needed to assess the optimal treatment. It would also be interesting to evaluate the effects of eccentric muscle training,[22,41] bipolar radiofrequency microtenotomy,[38] and sclerosing treatment[2] on proximal hamstring tendinopathy.

CONCLUSION

The major problem caused by proximal hamstring tendinopathy is pain, which limits sports, while the activities of daily living are often only minimally affected. In proximal hamstring tendinopathy, tenotomy of the semimembranosus tendon and exploration of the sciatic nerve is a valuable option and it yields highly successful return to sports in most cases. It is a safe and predictable procedure and has a low complication rate.

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