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Long-Term Prognosis of Patients With Achilles Tendinopathy

An Observational 8-Year Follow-up Study

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ABSTRACT

To determine the long-term outcome of patients treated nonoperatively for acute or subchronic (duration of the symptoms before initiation of the treatment less than 6 months) Achilles tendinopathy, we performed a follow-up analysis on 83 of 107 patients an average 8 ± 2 (SD) years after the initial contact. The analysis included a questionnaire, clinical examination, performance tests, muscle strength measurement, and ultrasonographic examination. Twenty-four of the 83 patients (29%) had to be operated on during the follow-up period. Seventy patients (84%) had full recovery of their activity level, and at 8 years' follow-up 78 patients (94%) were asymptomatic or had only mild pain with strenuous exercise. However, a clear side-to-side difference between the involved and the uninvolved sides was observed on the performance test, clinical examination, and ultrasonography. Also, 34 patients (41%) started to suffer from overuse symptoms in the initially uninvolved Achilles tendon. The results of our 8-year follow-up showed that the long-term prognosis of patients with acute-to-subchronic Achilles tendinopathy is favorable as determined by subjective and functional assessments. In the clinical and ultrasonographic examinations, mild-to-moderate changes were observed rather frequently in both the involved and initially uninvolved Achilles tendons, but the occurrence of these changes was not clearly related to the patients' symptoms.

Achilles tendon overuse injuries are commonly associated with physical activities, including running and jumping.[12,34] It has been recommended that the clinical syndrome, characterized by a combination of pain, swelling (diffuse or localized), and impaired performance, be labeled Achilles "tendinopathy."[25] Based on histopathologic examination findings, tendinopathy may be divided further into peritendinitis and tendinosis, and these entities may coexist. Clinically, however, such a division cannot be reliably made. In the acute phase of Achilles tendinopathy the tendon is diffusely swollen and edematous, and tenderness to palpation is usually greatest in the middle third of the tendon. Sometimes, crepitation due to the fibrin precipitated from the fibrinogen-rich fluid around the tendon can be observed.[6] The pain and stiffness often appear during the first steps in the morning or at the start of running, but these symptoms may decrease as the runner warms up.[11,19] For the patient, the most common practical problem of Achilles tendinopathy is the pain-induced limitation in sports and related activities; there is usually no restriction in normal daily activities.

In more chronic phases of Achilles tendinopathy, exercise-induced pain is still the cardinal symptom, while crepitation or effusion diminish. Frequently, tender nodules, as well as diffuse thickening of the soft tissues, can be seen around the tendon. In the worst cases, Achilles pain and discomfort may become constant, even with walking.[14]

The exact cause and pathogenesis of Achilles tendinopathy is still largely unknown, and neither prospective observational follow-up studies on the natural course of this complaint nor randomized treatment interventions with long-term follow-up have been published. Therefore, the treatment strategies recommended for Achilles tendinopathy vary considerably and the given treatment is frequently based on empirical experience only.[6] Patients

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with tendinopathy in the acute-to-subchronic phases have been treated with restriction of activity,[11] cryotherapy,[2] nonsteroidal antiinflammatory drugs,[2] intravenous injections of heparin,[16,30] glycosaminoglycan polysulfate injections,[33] local corticosteroid injection around the tendon,[11] heel lifts and orthoses,[2,18] strength and flexibility exercises,[2] and different forms of physical therapy.[9] For the chronic phase of Achilles tendinopathy, surgery has been considered an acceptable choice among patients who fail to respond to nonoperative treatment.[11,12,22,23,27,31,32]

The aim of this observational 8-year follow-up study was to examine the long-term results of nonoperative treatment for acute-to-subchronic Achilles tendinopathy. Specifically, the follow-up was designed to assess the long-term subjective, functional, and clinical outcome of patients with unilateral acute, subacute, or subchronic Achilles tendinopathy and to analyze the ultrasonographic findings from their Achilles tendons.

PATIENTS AND METHODS

Patients

During the period from 1985 through 1993, 107 patients (78 men and 29 women) who visited the Tampere Research Center of Sports Medicine for acute, subacute, or subchronic Achilles tendinopathy and met the following inclusion criteria formed the basic population of the study: 1) a diagnosis of unilateral, nonchronic Achilles peritendinitis based on clinical examination (defined as exertional pain and palpable tenderness in the Achilles tendon of less than 6 months' duration; patients with insertional complaints were excluded), 2) no previous Achilles tendon disorders, 3) age 16 to 65 years old, and 4) patient initially decided to try a nonoperative treatment strategy. Eighty-three of the original 107 patients (78%) could be followed an average of 8 ± 2 years after the initial contact. Of the 24 patients not included in the follow-up, 10 answered the follow-up questionnaire but did not attend the re-examination (1 patient died before re-examination, 1 emigrated, and 8 did not want to participate) and the other 14 could not be traced.

According to the delay between the onset of the symptoms of the Achilles tendinopathy and the initiation of the nonoperative treatment, the patients were divided into three subgroups: 1) acute, the treatment was started less than 14 days after the onset of the symptoms; 2) subacute, the treatment was started 14 to 42 days after onset of the symptoms; and 3) subchronic, the treatment was started 42 days to 6 months after onset of the symptoms. These subgroups were based solely on the duration, and not necessarily on the severity, of the symptoms.

The basic characteristics of the patients are presented in Table 1. The most common symptom-inducing activities were competitive running (18 patients, 22%), recreational outdoor jogging (18 patients, 22%), and orienteering (17 patients, 20%). Fifty-one patients (62%) were competitive athletes and 30 patients (36%) were recreational athletes; 2 patients (2%) did not participate in sports.

Treatment

In every patient, the nonoperative treatment strategy was individualized and initiated after the first clinical examination. The patient could receive more than one treatment, simultaneously or successively.

Modified rest (that is, rest of the injured site while allowing activity in the uninjured parts of the body) and gastrocnemius-soleus muscle stretching were recommended for everyone. Local peritendinous steroid injections were given 1 to 3 times in 69 patients (83%), glycosaminoglycan polysulfate injection was given to 26 patients (31%), and subcutaneous miniheparin was given to 1 patient (1%). Nonsteroidal antiinflammatory medication, with or without local antiinflammatory gels, was used by 35 patients (42%). Thirty-five patients (42%) used stan-

TABLE 1
Basic Characteristics of the Patients in the 8-year Follow-up Study of Acute-to-Subchronic Achilles Tendinopathy

Characteristic	Group[a]			Total (N = 83)
	Acute (N = 24)	Subacute (N = 24)	Subchronic (N = 35)	
Sex				
Male	18	17	26	61
Female	6	7	9	22
Mean age (years)	29 ± 9	34 ± 13	33 ± 11	32 ± 11
Affected side				
Right	15	9	11	35
Left	9	15	24	48
Mean weight (kg)				
Men	71 ± 7	72 ± 7	71 ± 8	71 ± 7
Women	58 ± 4	58 ± 6	64 ± 11	61 ± 8
Mean height (cm)				
Men	180 ± 5	177 ± 5	180 ± 6	179 ± 5
Women	169 ± 9	167 ± 5	168 ± 7	168 ± 7
Onset of the symptoms				
Very fast (within 24 hours)	7	10	8	25
Fast (within a few days)	8	7	5	20
Slow (longer than above)	9	7	22	38

[a] See text for definitions of groups.

dard-type heel lifts, and 12 patients (14%) received custom-made orthoses. Physical therapy was received by 12 patients (14%) and cryotherapy by 9 patients (11%).

The initial nonoperative treatment lasted from 2 weeks to 3 months. No extended treatment strategy and contacts were planned beyond this phase, that is, in the case of recurrent aggravation of the symptoms of Achilles tendinopathy the further strategy between nonoperative and surgical treatments was considered individually. The most important factors used to determine the initial or further treatment strategy included duration and severity of the symptoms, type and level of the symptom-inducing activity, biomechanical predisposing factors, and response of the symptoms to the initial nonoperative treatment.

Follow-up

The 8-year follow-up examination consisted of a questionnaire, clinical examination, performance tests, lower limb strength measurements, and ultrasonographic examination of both of the Achilles tendons. In every evaluation, the opposite (uninvolved) limb and Achilles tendon served as a control.

Questionnaire. The questionnaire provided information on the onset of the symptoms, subjective status of the injured and contralateral Achilles tendons, later treatments (including surgical treatment), and present physical activity.

Clinical Examination. The clinical examination was performed by one author (MP) with special emphasis on determining the presence of palpable tenderness and nodules in the Achilles tendons and their insertional areas. Intensity and the exact site of the tenderness were recorded.

Performance Tests. The performance of the lower limbs was determined by a standardized test protocol and scoring scale of Kaikkonen et al.[7] (Table 2). The subjective evaluation was based on three questions (items I, II, and III in the table) followed by evaluations of walking down a staircase, rising on heels and toes, and a balance test (items IV through VII). Finally, active range of motion of the ankles in dorsiflexion and plantar flexion (knee extended) and stability of ankle joints using the anterior drawer test were measured (items VIII and IX). The total test score for both lower limbs was then calculated.

Muscle Strength Measurement. The isometric extension strength of the lower limbs was measured separately for the involved and uninvolved sides using an isometric leg press dynamometer (Tamtron Inc., Tampere, Finland). The knee and ankle angles were fixed at 90°. Three maximal efforts were allowed and the median value was recorded.

Ultrasonographic Examination. Bilateral ultrasonographic examination of the Achilles tendons was performed at the Tampere University Hospital by a senior radiologist (TP). All ultrasonographic examinations were performed using a real-time linear array scanner with a 7.5-MHz transducer (Acuson Sequoia 512 Ultrasound System transducer, 8L5 38-mm linear MultiHertz, Acuson, Mountain View, California). Direct contact scanning with commercially available stand-off gel was used in every patient. The patients were examined in the prone position with their feet hanging over the edge of the scanning table. Both longitudinal and transverse images were obtained. The findings of the ultrasonographic examination were classified into four different categories (no pathologic alterations, mild abnormality, moderate abnormality, and severe abnormality) according to criteria presented in Table 3. In addition, the maximal sagittal diameter of the Achilles tendons was measured 2 to 3 cm above the posterior-superior corner of the calcaneus. In each patient, the diameters of the left and right Achilles tendons were measured at exactly the same level.

Statistical Analysis

The data were analyzed by using a personal computer running the 1997 version of the SPSS statistical software (SPSS Inc., Chicago, Illinois). The results of the questionnaire (subjective evaluation) were analyzed by a chi-

TABLE 2
A Scoring Scale for Performance Tests of the Lower Limbs[7]

Part	Description	Points[a]
I	Subjective assessment of the affected limb[b]	
	No symptoms of any kind	15
	Mild symptoms	10
	Moderate symptoms	5
	Severe symptoms	0
II	Can you walk normally?	
	Yes	15
	No	0
III	Can you run normally?	
	Yes	15
	No	0
IV	Climbing down stairs[c]	
	Under 18 sec	10
	18 to 20 sec	5
	Over 20 sec	0
V	Rising on heels	
	Over 40 times	10
	30 to 39 times	5
	Under 30 times	0
VI	Rising on toes	
	Over 40 times	10
	30 to 39 times	5
	Under 30 times	0
VII	Single-legged stance	
	Over 55 sec	10
	50 to 55 sec	5
	Under 50 sec	0
VIII	Laxity of the ankle joint (anterior drawer sign)	
	Stable (≤5 mm)	10
	Moderate instability (6–10 mm)	5
	Severe instability (>10 mm)	0
IX	Dorsiflexion range of motion	
	≥10°	10
	5°–9°	5
	<5°	0

[a] Excellent, 85 to 100; good, 70 to 80; fair, 55 to 65; poor, ≤50.
[b] Pain, swelling, stiffness, tenderness, or giving way during activity (mild, only one of these symptoms is present; moderate, two to three of these symptoms are present; severe, four or more of these symptoms are present).
[c] Four levels of staircase with 38 steps (height, 18 cm; depth, 38 cm).

TABLE 3
Ultrasonographic Classification of Achilles Tendon Abnormality

Classification	Intratendinous lesion	Peritendinous changes	Changes in retrocalcanear bursa	Insertional changes
No alteration	Homogeneous tendon structure. Parallel fiber bundles are clearly visible. No calcifications.	Clearly and sharp visible borders of the Achilles tendon. Normal echogenicity in the anterior border of the tendon.	Maximum diameter less than 10 mm and thickness less than 2 mm. Normal echo structure. Only slight fluid in the bursa. No calcification.	No calcification. Homogeneous fiber structure in the insertional area.
Mild abnormality	Intratendinous hypoechoic lesion, length 5 mm or less, diameter 1 mm or less. No calcifications. Minor alterations in echostructure of the fibers.	Hyperechoic adhesions in anterior border of the tendon, length 10 mm or less. Slight alterations in peritendinous echostructure.	Maximum diameter more than 10 mm, or thickness more than 2 mm but less than 4 mm. No calcification, only slight alterations in the bursal area.	Insertional calcification, length 10 mm or less and thickness less than 2 mm. Homogeneous fiber structure in the insertional area.
Moderate abnormality	Intratendinous hypoechoic lesion, length 5 to 15 mm and diameter less than 2 mm. Intratendinous calcification 5 mm or less in length.	Hyperechoic adhesions in the anterior border of the tendon, length more than 10 mm. Slight alterations in peritendinous echostructure.	Thickness more than 4 mm. Fluid accumulation in the bursa. Moderate alterations in the echo structure in the bursal area.	Insertional calcification, length more than 10 mm and thickness less than 2 mm. Slight alterations in the echo structure of tendon in the insertional area.
Severe abnormality	Intratendinous hypoechoic lesion, length more than 15 mm or diameter more than 2 mm. Intratendinous calcification more than 5 mm in length.	Hyperechoic adhesions in the anterior border of the tendon, length more than 10 mm and moderate to severe variety in peritendinous echostructure. Peritendinous calcification.	Thickness more than 4 mm. Severe fluid accumulation in the bursa. Severe alterations in the echo structure in the bursal area.	Insertional calcification, length more than 10 mm or thickness more than 2 mm. Moderate to severe variety in the echo structure of tendon in the insertional area.

square test. In the remaining frequency variables, comparisons of differences between the involved and uninvolved Achilles tendons and between the different subgroups (that is, between the patients in the acute, subacute, and subchronic groups) in the performance test, clinical evaluation, and ultrasonography (except sagittal diameter of the Achilles tendon) were performed by weighted least-squares method for repeated measurements. In continuous outcome variables (sagittal diameter of the Achilles tendon and muscle strength), one-way analysis of variance for independent groups was used to determine the side-to-side differences (between involved and uninvolved Achilles tendons) and differences between the subgroups.

In each part of the analysis an alpha level of less than 5% ($P < 0.05$) was considered significant. The given significance levels refer to two-tailed tests. The results of muscle strength measurement and sagittal diameter of the Achilles tendon are given as means ± standard deviation.

RESULTS

Need for Surgical Treatment

During the 8-year follow-up period, 24 of the 83 patients (29%) underwent surgical treatment of the affected Achilles tendon: 7 of the 24 patients (29%) in the acute group, 6 of the 24 patients (25%) in the subacute group, and 11 of the 35 patients (31%) in the subchronic group. The majority of the procedures (17 of the 24 operations [71%]) focused on the pathologic structures around the tendon (release of the peritendinous adhesions), but in 3 patients the surgery additionally revealed intratendinous lesions that were excised in every case. In one patient, an ultrasonographic examination performed 2 weeks previously did not show any changes in the fiber structure of the Achilles tendon; however, the Achilles tendon ruptured spontaneously while the patient was playing soccer 3 weeks after the onset of the symptoms of Achilles tendinopathy and the tendon was repaired. In the three remaining patients, the symptoms moved distally to the insertional area of the Achilles tendon, and surgery confirmed the presence of chronic retrocalcanear bursitis. The surgically treated patients recovered in 120 ± 30 (SD) days and the final outcome of these patients did not differ from those not needing surgery (data not shown).

Subjective Evaluation

The symptoms of the affected Achilles tendon, recovery of physical activity, and ability to walk and run are reported in Table 4.

Forty-nine of the 83 patients (59%) were asymptomatic at the final follow-up. Twenty-nine patients (35%) reported mild exertional pain, and four patients (5%) reported considerable pain, but only during strenuous exertion. The remaining patient was an enthusiastic male runner whose Achilles tendon had been treated initially by corticosteroid injections. At the follow-up, he felt pain

TABLE 4
The Results of the Subjective Evaluation

Subjective measurement	Group			Total (N = 83)
	Acute (N = 24)	Subacute (N = 24)	Subchronic (N = 35)	
Exertional pain of the involved Achilles tendon				
No pain	16	15	18	49
Mild pain with strenuous exertion	7	6	16	29
Considerable pain with strenuous exertion	1	3		4
Pain at rest			1	1
Physical activity				
Recovered to preinjury level	21	21	28	70
Decreased because of the injured Achilles tendon	3	3	7	13
Can you walk normally?				
Yes	24	23	35	82
No		1		1
Can you run normally?				
Yes	24	22	33	79
No		2	2	4

in the affected Achilles tendon even at rest, but he was still training daily.

Seventy of 83 patients (84%) had returned to their preinjury level of physical activity. Four patients (5%) could not run normally, and one patient could not walk normally because of Achilles tendon complaints (walking and running were considered normal when no limping existed, no pain existed in light or moderate activity, and no stiffness limited the range of motion of the ankle).

Between the different subgroups (acute, subacute, or subchronic), no statistically significant differences were observed in the subjective evaluation (exertional pain, P = 0.46; recovery of physical activity, P = 0.65).

Performance Tests

The distribution of the patients according to the four outcome categories on the performance test scale are presented in Table 5. In the performance test of the lower limbs, the uninvolved side was classified as excellent more frequently than the involved side (45 of 83 uninvolved lower limbs [54%] versus 35 of 83 involved lower limbs [42%], P = 0.03). There were, however, no statistically significant differences in the distribution of these test score categories between the different subgroups (acute, subacute, or subchronic) (P = 0.53).

Muscle Strength Measurement

In the isometric extension strength test of the involved and uninvolved lower limbs (the maximum extension strength of the entire lower limb), no statistically significant differences were observed between the involved and the uninvolved sides (P = 0.86), nor between the different subgroups (P = 0.16). In patients initially in the acute injury group, the mean extension strength was 106 ± 22 kg in the involved lower limb and 109 ± 21 kg in the uninvolved lower limb; in the subacute injury group, these numbers were 103 ± 22 kg (involved) and 103 ± 23 kg (uninvolved); and in the subchronic injury group, 103 ± 19 kg (involved) and 101 ± 19 kg (uninvolved).

Clinical Evaluation

In the clinical evaluation, a palpable tenderness was found more frequently in the involved Achilles tendon (35

TABLE 5
Distribution of the Patients According to the Performance Test Score Categories[a]

Score category	Group						Total (N = 83)	
	Acute (N = 24)		Subacute (N = 24)		Subchronic (N = 35)			
	Involved limb	Uninvolved limb	Involved limb	Uninvolved limb	Involved limb	Uninvolved limb	Involved limb	Uninvolved limb
Excellent (85–100)	11	16	11	12	13	17	35	45
Good (70–80)	10	7	11	10	19	15	40	32
Fair (55–65)	3	1	1	1	3	3	7	5
Poor (≤50)			1	1			1	1

[a] There were no significant group differences, although in the total group the uninvolved side was classified as excellent more frequently than the involved side (P = 0.03) (the weighted least-squares method for repeated measurements).

of 83 tendons [42%]) than in the uninvolved tendon (24 of 83 tendons [29%]), although the difference was not statistically significant ($P = 0.058$). In addition, no statistically significant differences were observed between the different subgroups ($P = 0.76$).

Palpable nodules were also found more frequently in the involved tendon (18 of 83 [22%]) than in the uninvolved tendons (11 of 83 [13%]), but the difference was not statistically significant ($P = 0.11$). Although these nodules were found more frequently in the patients in the acute injury subgroup, no statistically significant differences were observed between the different subgroups.

Findings from Ultrasonography

The results of the bilateral ultrasonographic examination of the Achilles tendons are shown in Table 6. In general, ultrasonography showed intratendinous abnormality more often in the involved Achilles tendon (29 of 83 tendons [35%]) than in the uninvolved tendons (18 of 83 tendons [22%]) ($P = 0.017$). This difference was especially obvious among the more severe changes classified as "moderate" or "severe" (Table 6). Between the subgroups, no significant differences were seen ($P = 0.58$).

Peritendinous abnormalities were observed in most of the involved Achilles tendons (60 of 83 [72%]) and in almost half of the uninvolved tendons (38 of 83 [46%]). This difference was statistically significant ($P < 0.001$). Between the subgroups, no significant differences were seen ($P = 0.98$).

In the insertional area (Achilles insertion and retrocalcanear bursa), pathologic changes were found less frequently than in the more proximal part of the Achilles tendon. Changes in the retrocalcanear bursa were observed in 12 of 83 Achilles tendons (14%) in the involved side as well as in the uninvolved side, and insertional changes were found in only 6 involved tendons (7%) and 1 uninvolved tendon (1%). These differences were not statistically significant, and the subgroup differences were not statistically significant either.

The involved-to-uninvolved side differences in the maximal sagittal diameter of the Achilles tendons were small (Table 6). This side-to-side difference was statistically significantly larger in the acute group than in the subacute group (group difference 1.1 mm, $P = 0.013$) and subchronic group (difference 0.9 mm, $P = 0.033$).

Initially Uninvolved Achilles Tendon

During the 8-year follow-up, symptoms of overuse (exertional pain with or without swelling and stiffness) developed in the initially uninvolved Achilles tendon in 34 of the 83 patients (41%). The appearance of these overuse symptoms was somewhat more common in the subchronic group (16 of 35 patients [46%]) than in the acute group (8 of 24 patients [33%]) or subacute group (9 of 24 patients [38%]), but the difference was not significant ($P = 0.46$). In 5 of 83 patients (6%), the initially uninvolved Achilles tendon was operated on during the follow-up period: 1 of the 24 patients (4%) in the acute group, 2 of the 24 pa-

TABLE 6
The Results of the Ultrasonographic Examination

Ultrasonographic finding	Group						Total ($N = 83$)	
	Acute ($N = 24$)		Subacute ($N = 24$)		Subchronic ($N = 35$)			
	Involved limb	Uninvolved limb	Involved limb	Uninvolved limb	Involved limb	Uninvolved limb	Involved limb	Uninvolved limb
Intratendinous lesion								
None	14	19	17	21	23	25	54	65
Mild	7	4	1	3	8	7	16	14
Moderate	1	1	6		4	2	11	3
Severe	2					1	2	1
Peritendinous changes								
None	8	15	5	12	10	18	23	45
Mild	9	6	11	7	12	8	32	21
Moderate	6	2	6	5	11	9	23	16
Severe	1	1	2		2		5	1
Changes in the retrocalcanear bursa								
None	18	20	21	20	32	31	71	71
Mild	5	3	3	3	3	2	11	8
Moderate	1	1		1		2	1	4
Severe								
Insertional changes								
None	24	24	21	23	32	35	77	82
Mild			1		3		4	
Moderate			2				2	
Severe				1				1
Diameter of the Achilles tendon[a] (mm)	7.0 (±1.8)	5.7 (±0.8)	6.5 (±1.3)	6.3 (±1.4)	6.4 (±1.3)	6.0 (±1.3)	6.6 (±1.5)	6.0 (±1.2)

[a] The maximal sagittal diameter of the Achilles tendon was measured 2 to 3 cm above the posterior superior corner of the calcaneus (in the right and left Achilles tendons of the same patient, the measurement was always done exactly at the same level).

tients (8%) in the subacute group, and 2 of the 35 patients (6%) in the subchronic group.

DISCUSSION

Our observational 8-year follow-up study showed that the long-term prognosis of patients with acute-to-subchronic Achilles tendinopathy is generally good and acceptable. Seventy of the 83 patients (84%) fully recovered their physical activity level, and at an average of 8 years after surgery, 78 patients (94%) were asymptomatic or had only mild pain with strenuous exercise. However, a clear side-to-side difference between the involved and the uninvolved sides was observed on the performance test, clinical examination, and ultrasonography. Also, 34 of the 83 patients (41%) started to suffer from overuse symptoms (exertional pain with or without swelling and stiffness) in the initially uninvolved Achilles tendon. On the involved side, delay of up to 6 months between the onset of the symptoms and initiation of nonoperative treatment did not have any remarkable effect on the long-term outcome.

Although this study is the first prospective long-term follow-up of patients with acute-to-subchronic Achilles tendinopathy (using subjective, functional, and clinical assessments as well as ultrasonographic examination as outcome criteria), it has two clear limitations and they need to be considered. First, as no consensus exists on how to treat a patient with Achilles tendinopathy, the nonoperative treatment initiated after the first examination was not uniform in this study. All patients were recommended modified rest and gastrocnemius-soleus muscle stretching, and many of the patients (83%) received one to three local peritendinous corticosteroid injections. Second, at the initiation of the study, neither ultrasonographic nor MRI scans of the Achilles tendon were obtained, and thus it is not known whether some of the peri- or intratendinous follow-up findings were present before treatment. On the other hand, according to a recent prospective follow-up of patellar tendons in female basketball players,[10] occurrence of imaging abnormalities at baseline was a poor predictor of the development of jumper's knee. Because this discrepancy has been recognized in our clinical practice for a long time, it is unlikely that baseline imaging studies would have changed the results of the current follow-up.

In a retrospective study, Kvist[13] found that 24% of 411 patients with Achilles tendinopathy and insertional pain needed surgical treatment. Leppilahti et al.[24] reported in their retrospective study that 46% of their 273 patients with overuse injuries of the Achilles tendon were treated surgically. In a more recent retrospective study by Johnston et al.[5] an even greater proportion of the patients with chronic Achilles tendon disorder (20 of the 41 patients, or 49%) was reported to need surgical treatment. The different proportions of the patients needing surgical treatment in these retrospective studies might be due to differences in the selection of the patients in the study, variability in the treatment strategies between the clinics, or difference in the duration of the follow-up period. In our 8-year follow-up, 29% of the patients with acute or subchronic Achilles tendinopathy did not have success with nonoperative treatment and these patients were operated on. The forthcoming years will show whether additional operations will be needed.

In our study, the final outcome of the surgically treated patients did not differ from that of the nonoperatively treated patients. However, no randomized treatment intervention was attempted; thus, the patients treated surgically may have differed already at baseline from those treated nonoperatively (the nonresponding cases are more likely to become included in the surgical group). Thus, in this study, comparison of patients with surgical versus nonsurgical treatment was not an adequate procedure and therefore these data were not presented in detail.

Tendon degeneration, resulting in reduction of the tensile strength of the tendon, may predispose an Achilles tendon to spontaneous rupture,[6] but only 4% to 33% of the patients with complete Achilles tendon rupture have been reported to have preexisting symptoms.[1,8,17] Tendon ruptures have also been suspected to be associated with the use of local injections of corticosteroids, but the true effect of peritendinous injection on risk of tendon rupture is still unknown, and therefore well-controlled clinical studies are needed.[3,6,20] In our study, one patient had suffered from symptoms of Achilles tendinopathy for 2 weeks and was examined with ultrasonography (in which no intratendinous abnormality was found). This patient received a peritendinous injection of corticosteroid and glycosaminoglycan polysulfate. One week after the injection, he sustained a complete Achilles tendon rupture in a soccer match. In interpreting this occurrence, we have to remember that the main reason for the rupture may not have been the degenerating effects of the cortisone but its antiinflammatory effect (quick pain relief and consequently quick return to strenuous physical activity). Today, it is widely believed that a judicious use of locally injected corticosteroid—that is, limited number of injections (1 to 3), no intratendinous injection, no injection of chronic tendon disorders (tendinosis), no use of substances with long-lasting effects such as triamcinolone, and dilution of the corticosteroid with local anesthetic before the injection—is likely to have minimal adverse effect on the target tendon.[6,14,20]

Although the long-term prognosis of patients with acute-to-subchronic Achilles tendinopathy seems good and acceptable (physical activity was fully recovered in 84% of the patients and 94% of the patients were asymptomatic or had only mild pain in strenuous exercise), palpable tenderness was found in 42% and palpable nodules in 22% of the involved Achilles tendons at the 8-year follow-up. In the contralateral Achilles tendons, the palpable tenderness and palpable nodules were observed less frequently (in 29% and 13%, respectively). On the other hand, this tenderness in the Achilles tendon was usually mild; moderate or severe tenderness to palpation was found in only 8% of the involved and 5% of the contralateral Achilles tendons. In addition, since the delay between the onset of the symptoms and the initiation of the nonoperative treatment did not affect these results, the clinical relevance of

the palpable tenderness and nodules in the Achilles tendon remain questionable and without strong evidence.

Ultrasonographic examination has been reported to reliably visualize the indistinct borders of the tendon and thickening of the anterior border of the tendon in patients with Achilles tendinopathy.[15,28] In the Achilles tendon with tendinosis, ultrasonography can identify the intratendinous hypoechoic lesions and the altered structure of the tendon.[15,21,26] Preoperative ultrasonographic findings concerning intratendinous degenerative lesions or peritendinous abnormality of the Achilles tendon, when compared with subsequent surgical findings, have also been demonstrated to be very reliable.[28] In the present study, the pathologic ultrasonographic findings were rather common, and the involved side was affected more frequently than the uninvolved side. The delay between the onset of the symptoms and the initiation of the nonoperative treatment did not, however, affect the main results of the ultrasonographic examination, although the side-to-side difference in the sagittal diameter of the tendon was larger in the acute injury group than in the subacute or subchronic injury groups. Abnormal ultrasonographic findings were especially common in peritendinous tissues; in 72% of the involved and in 46% of the contralateral Achilles tendons the paratenon was abnormal. The peritendinous changes were, however, usually mild or moderate and were often located in the anterior border of the distal Achilles tendon. Many of the patients with ultrasonographic peritendinous changes were asymptomatic or had only mild pain after strenuous exercise, and these changes were common in the contralateral side as well (Table 6).

Degeneration of the tendon can develop without clinical symptoms, and the tendon can become symptomatic with heavy training.[29] In a study by Kannus and Józsa,[8] preexisting degenerative changes were demonstrated histologically in nearly all tendons with a spontaneous rupture. However, the exact role of the intratendinous lesions in the pathogenesis of the Achilles tendon overuse injuries, symptoms of the patient, and, in particular, treatment of the patient is not known.[6] In the surgical treatment of a degenerative intratendinous lesion, longitudinal incision of the tendon and sharp excision of the degenerative lesion have been recommended.[4,12,23,27,31,32] In the present study, a few patients had mild intratendinous ultrasonographic changes of the Achilles tendon at the follow-up; however, these patients did not have considerable clinical symptoms.

Almost all known intrinsic and extrinsic predisposing factors to Achilles tendon overuse injuries are sometimes seen bilaterally. Thus, it is not known what structures or abnormal findings in the imaging or surgery of the Achilles tendon are actually responsible for the pain and related symptoms. In this study, mild-to-moderate peritendinous and intratendinous changes were seen rather frequently in the contralateral Achilles tendon, but these tendons did not have considerable symptoms. Thus, these ultrasonographic changes could have been induced, at least partly, by the long-standing exertion alone.

The coexistence of Achilles tendinopathy and insertional complaint has been reported previously.[6,32] In this study, in 3 of the 83 patients (4%) with initially noninsertional Achilles tendinopathy, the exertional pain also appeared in the insertional area and needed surgical treatment. In addition, ultrasonography showed pathologic changes in some patients' retrocalcanear bursae (in 14% of the involved and uninvolved tendons) and in the Achilles insertion (in 7% of the involved tendons and 1% of the uninvolved tendons). As with abnormal peritendinous and intratendinous ultrasonographic findings, the patients with changes in the insertional area were asymptomatic or had mild pain during strenuous exercise only. Nevertheless, we recommend that the insertional area should be carefully examined during the clinical examination and imaging studies, and in patients with noninsertional Achilles tendinopathy.

In summary, this prospective observational follow-up showed that the 8-year prognosis of patients with acute or subchronic Achilles tendinopathy was generally favorable as determined by subjective and functional assessments. However, 29% of the patients had to be operated on during the follow-up period. In the clinical and ultrasonographic examinations, nonsevere changes were observed rather frequently in both the involved and initially uninvolved Achilles tendons, but the occurrence of these changes was not clearly related to patients' symptoms. Further studies are needed to determine the role of the mild peritendinous and intratendinous changes in the cause and pathogenesis of Achilles tendon overuse injury, related symptoms, and, in particular, treatment and prognosis of the patient. In addition, even longer follow-up studies are needed to determine the truly long-term course of the problem.

REFERENCES

1. Bradley JP, Tibone JE: Percutaneous and open surgical repairs of Achilles tendon ruptures. A comparative study. *Am J Sports Med 18:* 188–195, 1990
2. Clement DB, Taunton JE, Smart GW: Achilles tendinitis and peritendinitis: Etiology and treatment. *Am J Sports Med 12:* 179–184, 1984
3. Fredberg U: Local corticosteroid injection in sport: Review of literature and guidelines for treatment. *Scand J Med Sci Sports 7:* 131–139, 1997
4. Järvinen M: Lower leg overuse injuries in athletes. *Knee Surg Sports Traumatol Arthrosc 1:* 126–130, 1993
5. Johnston E, Scranton P Jr, Pfeffer GB: Chronic disorders of the Achilles tendon: Results of conservative and surgical treatment. *Foot Ankle 18:* 570–574, 1997
6. Jozsa LG, Kannus P: *Human Tendons: Anatomy, Physiology, and Pathology.* Champaign, IL, Human Kinetics, 1997
7. Kaikkonen A, Kannus P, Järvinen M: A performance test protocol and scoring scale for the evaluation of ankle injuries. *Am J Sports Med 22:* 462–469, 1994
8. Kannus P, Józsa L: Histopathological changes preceding spontaneous rupture of a tendon. A controlled study of 891 patients. *J Bone Joint Surg 73A:* 1507–1525, 1991
9. Kellett J: Acute soft tissue injuries—a review of the literature. *Med Sci Sports Exerc 18:* 489–500, 1986
10. Khan KM, Cook JL, Kiss ZS, et al: Patellar tendon ultrasonography and jumper's knee in female basketball players: A longitudinal study. *Clin J Sport Med 7:* 199–206, 1997
11. Kvist H, Kvist M: The operative treatment of chronic calcaneal paratenonitis. *J Bone Joint Surg 62B:* 353–357, 1980
12. Kvist M: Achilles tendon injuries in athletes. *Sports Med 18:* 173–201, 1994
13. Kvist M: Achilles tendon injuries in athletes. *Ann Chir Gynaecol 80:* 188–201, 1991
14. Kvist M: Achilles tendon overuse injuries. Academic dissertation. Turku, University of Turku, Finland, 1991

15. Laine HR, Harjula ARJ, Peltokallio P: Ultrasonography as a differential diagnostic aid in achillodynia. *J Ultrasound Med 6:* 351–362, 1987
16. Larsen AI, Egfjord M, Jelsdorff HM: Low-dose heparin in the treatment of calcaneal peritendinitis. *Scand J Rheumatol 16:* 47–51, 1987
17. Lea RB, Smith L: Non-surgical treatment of tendo Achillis rupture. *J Bone Joint Surg 54A:* 1398–1407, 1972
18. Leach RE, Dilorio E, Harney RA: Pathologic hindfoot conditions in the athlete. *Clin Orthop 177:* 116–121, 1983
19. Leach RE, James S, Wasilewski S: Achilles tendinitis. *Am J Sports Med 9:* 93–98, 1981
20. Leadbetter WB: Anti-inflammatory therapy in sports injury: The role of nonsteroidal drugs and corticosteroid injection. *Clin Sports Med 14:* 353–410, 1995
21. Lehtinen A, Peltokallio P, Taavitsainen M: Sonography of Achilles tendon correlated to operative findings. *Ann Chir Gynaecol 83:* 322–327, 1994
22. Lehto MUK, Järvinen M, Suominen P: Chronic Achilles peritendinitis and retrocalcanear bursitis. Long-term follow-up of surgically treated cases. *Knee Surg Sports Traumatol Arthrosc 2:* 182–185, 1994
23. Leppilahti J, Karpakka J, Gorra A, et al: Surgical treatment of overuse injuries to the Achilles tendon. *Clin J Sport Med 4:* 100–107, 1994
24. Leppilahti J, Orava S, Karpakka J, et al: Overuse injuries of the Achilles tendon. *Ann Chir Gynaecol 80:* 202–207, 1991
25. Maffulli N, Khan KM, Puddu G: Overuse tendon conditions: Time to change a confusing terminology. *Arthroscopy 14:* 840–843, 1998
26. Maffulli N, Regine R, Angelillo M, et al: Ultrasound diagnosis of Achilles tendon pathology in runners. *Br J Sports Med 21:* 158–162, 1987
27. Nelen G, Martens M, Burssens A: Surgical treatment of chronic Achilles tendinitis. *Am J Sports Med 17:* 754–759, 1989
28. Paavola M, Paakkala T, Kannus P, et al: Ultrasonography in the differential diagnosis of Achilles tendon injuries and related disorders. A comparison between pre-operative ultrasonography and surgical findings. *Acta Radiol 39:* 612–619, 1998
29. Puddu G, Ippolito E, Postacchini F: A classification of achilles tendon disease. *Am J Sports Med 4:* 145–150, 1976
30. Rais O: Heparin treatment of peritenomyosis (peritendinitis) crepitans acuta. A clinical and experimental study including the morphological changes in peritenon and muscle. *Acta Chir Scand (Suppl 268):* 1–88, 1961
31. Schepsis AA, Leach RE: Surgical management of Achilles tendinitis. *Am J Sports Med 15:* 308–315, 1987
32. Schepsis AA, Wagner C, Leach RE: Surgical management of Achilles tendon overuse injuries. A long-term follow-up study. *Am J Sports Med 22:* 611–619, 1994
33. Sundqvist H, Forsskåhl B, Kvist MH: A promising novel therapy for Achilles peritendinitis: Double-blind comparison of glycosaminoglycan polysulphate and high-dose indomethacin. *Int J Sports Med 8:* 298–303, 1987
34. Williams JGP: Achilles tendon lesions in sport. *Sports Med 16:* 216–220, 1993