

Surgical treatment for chronic Achilles tendinopathy: a prospective seven month follow up study

M Paavola, P Kannus, S Orava, M Pasanen, M Järvinen

Br J Sports Med 2002;**36**:178–182

Objective: To prospectively assess the early results of surgical treatment of chronic Achilles tendinopathy.

Methods: This seven month prospective follow up study assessed the short term results of surgical treatment of chronic Achilles tendinopathy and compared the subjective and functional outcome of patients with Achilles tendinopathy without a local intratendinous lesion (group A) with that of similar patients with such a lesion (group B). Forty two of the initial 50 patients were examined before surgery and after the seven month follow up. Evaluation included an interview, subjective evaluation, clinical tests, and a performance test.

Results: At the follow up, physical activity was fully restored in 28 of the 42 patients (67%), and 35 patients (83%) were asymptomatic or had only mild pain during strenuous exercise. In clinical tests, significant improvements were observed in climbing up and down stairs and the rising on the toes test. Surgical treatment also seemed to be successful from the total test score, which was excellent or good in 35 patients, compared with before surgery when it was excellent or good in one patient only. Patients in group A fared better than those in group B, whether evaluated by recovery of physical activity after surgery (88% v 54%) or the complication rate (6% v 27%).

Conclusions: Surgical treatment of chronic Achilles tendinopathy gives good and acceptable short term results. A lower complication rate and a trend to better recovery was observed in patients with peritendinous adhesions only than in those with peritendinous adhesions combined with an intratendinous lesion.

See end of article for authors' affiliations

Correspondence to:
Dr Paavola, Institute of
Medical Technology,
PO Box 607, FIN-33101
Tampere, Finland;
mika.paavola@hus.fi

Accepted
15 January 2002

It has been suggested that the common clinical syndrome of the Achilles tendon characterised by pain, swelling, and impaired performance should be called Achilles tendinopathy.¹ On histopathological examination, tendinopathy can be divided into peritendinitis and tendinosis (tendon degeneration), which can coexist. During surgery for Achilles tendinopathy, tight adhesions around the thickened paratenon (especially between the paratenon and the crural fascia) can be observed in the case of pure Achilles peritendinitis.² In the case of coexisting tendinosis, surgical exploration also shows an intratendinous lesion.^{2, 3}

The exact cause and pathogenesis of Achilles tendinopathy is largely unknown, and no randomised studies of treatment with long term follow up have been published. Therefore, the treatment strategies for Achilles tendinopathy vary considerably, and the treatment given is often based on empirical experience only.²

In the early phases of Achilles tendinopathy, various conservative treatments are normally used.^{2, 4–10} Surgery is reserved for patients who do not respond adequately to conservative treatment.^{6, 11–17} Excision of the pathological peritendinous tissue⁶ or longitudinal incisions of the tendon, alone or with excision of intratendinous lesion, are the types of surgery normally used.² Excision of the intratendinous lesion has been made without augmentation,¹⁶ or with augmentation using tendon or fascia as the augmentation material.¹⁴ Multiple longitudinal incisions have also been performed percutaneously.^{18, 19}

The aim of this prospective seven month follow up study was to assess the early results of surgical treatment of chronic Achilles tendinopathy and to analyse the subjective and functional outcome in patients with or without a local intratendinous lesion.

PATIENTS AND METHODS

Patients

From August 1995 to November 1998, 50 patients (36 men, 14 women) were treated surgically for Achilles tendinopathy at the Tampere University Hospital, Tampere and Hospital Tohtoritälö 41400, Turku, Finland, and all of them agreed to participate in the prospective follow up. All operations were performed by two senior orthopaedic surgeons (SO and MJ). Patients with disorders at the Achilles insertion (insertional tendinopathy) or previous surgical treatment of the index tendon were excluded.

In 10 patients, the contralateral Achilles tendon had been previously operated on for an Achilles tendon overuse injury. At baseline, three other patients had exercise induced Achilles pain on this contralateral side also. Therefore the contralateral Achilles tendon could not be used as a control. Instead, the preoperative or baseline values of the index Achilles tendon were used as the basis for the follow up observations.

Forty two of the original 50 patients (84%) were followed up a mean (SD) of 7 (0.7) months after the operation. Of the eight not followed up, five could not find time to attend the follow up examination, one was operated on four weeks after the initial operation because of a rapidly worsening Achilles tendon disorder on the contralateral side, one could not attend because of low back pain and sciatica, and the remaining patient could not be traced.

Table 1 presents the basic characteristics of the patients. The most common symptom-inducing activities were recreational outdoor jogging (16 patients, 38%), competitive running (four patients, 10%), soccer (four patients, 10%), and tennis (four patients, 10%). Eleven patients (26%) were competitive athletes, 26 (62%) were recreational athletes, and five (12%) did not participate in any sport.

The diagnosis was based on a history of Achilles pain during exertion and on clinical findings (palpable tenderness,

Table 1 Basic characteristics of the 16 patients with Achilles tendinopathy with peritendinous adhesions (group A) and 26 patients with Achilles tendinopathy with peritendinous adhesions and intratendinous lesion (group B)

Characteristic	Group A	Group B
Sex		
Male	12	17
Female	4	9
Age (years)	37 (12)	46 (14)
Weight (kg)		
Men	83 (14)	83 (10)
Women	62 (6)	70 (7)
Height (cm)		
Men	180 (6)	179 (7)
Women	168 (2)	170 (6)
Affected side		
Right	11	13
Left	5	13

Where applicable, values are mean (SD).

thickening, and, sometimes, palpable nodules at the Achilles tendon). In addition, to confirm the clinical diagnosis, ultrasound and/or magnetic resonance imaging (MRI) examinations were performed in most of the subjects (ultrasound in 15 patients, MRI in two patients, both ultrasound and MRI in 18 patients, and clinical examination alone in seven patients).

In all patients, the overuse symptoms had not been relieved by conservative treatment (mean length of the conservative treatment was 18 months, range 3–192 months). Initially, all patients had been advised to rest or substantially reduce their athletic activities. In addition, 31 of the 42 patients (74%) had been treated with a small amount of corticosteroid, injected between one and four times around the Achilles tendon, and anti-inflammatory medication had been used by almost all of the patients. In all patients, the indications for surgical treatment was failure of the above non-operative treatment—that is, the patient's inability to continue physical activities without pain, persistent swelling around the Achilles tendon, or both.

Surgical treatment

All patients were operated on as outpatients. Spinal anaesthesia was used in 19 of the 42 patients (45%), local intravenous anaesthesia in 19 (45%), and local anaesthesia in four (10%).

During surgery, the patient was prone. A tourniquet was used in the 19 patients who had local intravenous anaesthesia, otherwise only occasionally (in the cases of a large intratendinous lesion). A longitudinal incision was made to the lateral side of the Achilles tendon, and the small subcutaneous veins were coagulated with diathermy. The distal part of the small saphenous vein and the sural nerve were carefully identified, freed by blunt dissection, and retracted anteriorly.

The final surgical diagnosis was chronic Achilles tendinopathy with peritendinous adhesions in 16 of the 42 patients (38%; group A) and chronic Achilles tendinopathy with peritendinous adhesions and a localised intratendinous lesion in 26 of the 42 patients (62%; group B).

In all 16 patients in group A, the crural fascia was incised and the adhesions, especially those between the paratenon and the crural fascia, were carefully excised, leaving intact as many layers of the true Achilles paratenon as possible. In the 26 patients in group B, an additional longitudinal incision of the tendon itself was performed and the intratendinous lesion removed. When the lesion was extensive, the remaining tendon was reapproximated by side to side sutures.

Regimen after surgery

Ankle mobilisation and partial weight bearing with the aid of crutches were gradually started immediately after surgery.

Stretching exercises for the Achilles tendon-gastrocnemius muscle complex were initiated and full weight bearing was allowed when the patient was able to walk without limping, usually one to two weeks after surgery. Light sports specific training was allowed when there was no pain on walking and no limitation in the active range of motion of the ankle joint, usually four to six weeks after the operation. Full sports specific training was allowed 6–12 weeks after surgery.

Study protocol

Each patient was examined by the same doctor (MP) at study entry (before surgery) and after the seven month follow up. The study protocol was the same at both checkup points. In addition, all the patients were examined two to three weeks after surgery by the operating surgeon to evaluate any early complications and wound healing.

Interview and subjective evaluation

The interview and subjective evaluation provided information about the symptoms of the Achilles tendon, ability to walk and run, and current physical activity. At the end of the follow up period, possible complications were also re-evaluated.

Clinical tests

Ability to climb up and down stairs was evaluated using two floors with 40 steps (height, 17 cm; depth, 30 cm). In the rising on to toes test, the subject was asked to rise on to tiptoe with one leg as many times as possible at the pace of 60 times per minute to measure fatigue of the ankle plantar flexor muscles. The full range of motion of the ankle was measured using a goniometer (Biomet Inc, Warsaw, Indiana, USA), and calf circumference was measured with a measuring tape at the border of the upper and middle third of the fibula.

Performance test protocol

The performance of the lower limbs was determined by a standardised test protocol and scoring scale of Kaikkonen *et al.*²⁰ The subjective evaluation was based on three “yes” or “no” questions (subjective assessment of the affected limb, ability to walk normally, ability to run normally) followed by evaluations of walking downstairs, rising on to heel and toes, and a balance test. Finally, an active range of motion of the ankle in dorsiflexion (knee extended) and stability of the ankle joint using the anterior drawer test were measured. The total test score was then calculated.

Statistical analysis

The data were analysed with an IBM compatible microcomputer using the 1997 version of the SPSS statistical software (SPSS Inc, Chicago, Illinois, USA).

The results of the subjective assessment of the “symptoms of the Achilles tendon” and “ability to walk” and “run” were analysed by the McNemar test, but statistical tests of the differences between groups A and B could not be performed because of empty cells in the cross tabs—that is, in group A, there were no patients who could not walk normally after surgery and no patient who could run normally before surgery. In the remaining frequency variables (“recovery of physical activity” and “subjective assessment of the symptoms in the index Achilles tendon”), the comparison of differences between the subgroups was performed by the χ^2 test.

In many of the continuous variables (rising on to toes, range of motion of the ankle, the calf circumference, and climbing up and down stairs), the assumption of normality in case distribution was not filled—that is, the distributions were skewed—and therefore non-parametric tests were used for analysis: the Wilcoxon signed rank test was used to determine the intragroup differences between the preoperative and post-operative tests, and the Mann-Whitney U test to determine the differences in the improvement after surgery between groups A and B. Although the results of the performance test

Table 2 Seven month clinical follow up evaluation of 16 patients with Achilles tendinopathy with peritendinous adhesions (group A) and 26 patients with Achilles tendinopathy with peritendinous adhesions and an intratendinous lesion (group B)

Variable	Group A			Group B			Significance between groups A and B at the 7 month follow up, comparing improvement by time between the groups†
	Before surgery	p Value*	7 month follow up	Before surgery	p Value*	7 month follow up	
Climbing upstairs (seconds)	17 (4)	0.006	15 (2)	20 (6)	0.001	17 (4)	NS
Climbing downstairs (seconds)	20 (7)	0.001	15 (2)	22 (10)	0.001	17 (5)	NS
Rising on toes (number)	26 (14)	0.055	30 (10)	21 (15)	0.04	25 (13)	NS
ROM of the ankle (degree)	58 (9)	NS	55 (8)	55 (11)	NS	57 (11)	NS
Calf circumference (cm)	38 (3)	NS	38 (3)	37 (2)	NS	37 (2)	NS

Values are mean (SD).

*Wilcoxon signed rank test.

†Mann-Whitney U test.

ROM, Range of motion.

were classified into four different score categories (table 3), the test to test differences (determined by Wilcoxon signed rank test) and differences between the two groups (determined by Mann-Whitney U test) were assessed using a continuous variable, the total performance test score (table 3). The results of the continuous variables are given as a mean (SD) throughout the study unless specified differently.

RESULTS

Subjective evaluation

At the start of the study, 12 of the 16 patients (77%) in group A and 23 of the 26 patients (88%) in group B had moderate to severe symptoms in the index Achilles tendon. After the seven month follow up period, subjective assessment of these Achilles symptoms showed clear improvement: 15 of the 16 patients (94%) in group A and 20 of the 26 patients (79%) in group B were asymptomatic or had only mild symptoms during strenuous exercise (improvement in group A, $p = 0.001$; improvement in group B, $p < 0.001$). There were no significant differences in the subjective assessment of the injured Achilles tendon before or after surgery between the patients in the two groups ($p = 0.376$ and $p = 0.322$ respectively).

When recovery of physical activity was evaluated, the patients in group A fared better than those in group B: physical activity had returned to the level before injury in 14 of the 16 patients (88%) in group A and in 14 of the 26 patients (54%) in group B (between group difference, $p = 0.025$).

In both groups, subjective assessment of the ability to walk and run showed significant improvement after surgery of the index Achilles tendon. Before surgery, only 10 of the 16 patients (63%) in group A were able to walk normally and none of them were able to run normally (walking and running

was considered normal when there was no limp, no pain during light or moderate activity, and stiffness did not limit the range of motion of the ankle). After surgery and the follow up period, all 16 patients in group A could walk normally and 15 of these 16 patients could run normally (walking, $p = 0.031$; running, $p < 0.001$). In group B, only 14 of the 26 patients were able walk normally and two were able to run normally before surgery, whereas at the end of the follow up period, 24 could walk normally and 20 could run normally (walking, $p = 0.006$; running, $p < 0.001$).

Clinical tests

Table 2 gives the result of the clinical tests. Significant improvements in the climbing up and down stairs tests and the rising on toes test were seen in both groups. However, there were no significant differences between the two groups with respect to these improvements.

The range of motion of the ankle and the calf circumference showed neither significant intragroup changes during the follow up period nor significant differences between the two groups.

Performance test

Table 3 presents the distribution of the patients according to the four categories of the total scores in the performance test protocol. In the performance test on the involved lower limb, there were no significant differences in the distribution of the test score between the two groups before surgery ($p = 0.21$). However, after surgery, it was classified as "good" or "excellent" in all patients in group A, whereas in group B it was classified as "good" or "excellent" in only 19 of the 26 patients (73%). The improvement in the median of the

Table 3 Distribution of the patients according to the performance test score categories and the median (range) of the total score of the involved Achilles tendon in the 16 patients with Achilles tendinopathy with peritendinous adhesions (group A) and 26 patients with Achilles tendinopathy with peritendinous adhesions and intratendinous lesion (group B)

Score category of involved Achilles tendon	Group A		Group B	
	Before surgery	7 month follow up	Before surgery	7 month follow up
Excellent (85–100)	–	5	–	7
Good (70–80)	–	11	1	12
Fair (55–65)	6	–	8	1
Poor (≤ 50)	10	–	17	6
Median (range)*	50 (25–65)	80† (70–95)	48 (15–70)	75† (15–100)

*Maximum value = 100

†Wilcoxon signed rank test tested the intragroup score change by time. In both groups, this change was significant ($p < 0.001$), showing, however, no significant intergroup difference in the score improvement (Mann-Whitney U test).

performance test score was significant in both groups ($p < 0.001$ for both), without a significant between groups difference in the improvement (table 3).

Complications

There were eight complications in the 42 patients (19%) treated surgically for Achilles tendinopathy: four superficial wound infections; two skin edge necroses; two fibrotic reactions or scar formations. Complications were found more often in patients in group B (seven of the 26 patients (27%) in group B *v* one of the 16 patients (6%) in group A), although the difference was not significant ($p = 0.098$).

DISCUSSION

The goal for the treatment of chronic Achilles tendinopathy is to return the patient to the desired level of physical activity without significant residual pain. In athletes, the recovery time should also be as short as possible.

Our prospective seven month follow up study shows that the short term results of surgical treatment of chronic Achilles tendinopathy were satisfactory. Full physical activity was restored in 28 of the 42 patients (67%), and 35 patients (83%) were asymptomatic or had only mild pain during strenuous exercise. In clinical tests, clear improvement was observed. In addition, using the performance test protocol as the criterion, the surgical treatment of the Achilles tendinopathy seemed successful.

Although this study is the first prospective follow up report of patients receiving surgery for Achilles tendinopathy (using subjective, clinical, and functional tests as outcome variables), it has two clear limitations. Firstly, although "recovery to the previous level of activity in the shortest possible time" is often emphasised in athletes, a longer follow up is needed to determine the true long term outcome of the surgery. Secondly, we were unable to include a group of non-operatively treated controls, matched for age, sex, and physical activity. A randomised controlled trial is needed to fulfil this requirement.

Cetti *et al*²¹ observed that the overall complication rate in 4083 surgically treated complete Achilles tendon ruptures was 12%. Recently, an overall complication rate of 11% was documented in a series of 432 consecutive patients after surgical treatment for chronic Achilles tendon overuse injury.²² In that study, most (54%) of the complications involved compromised wound healing, which seemed to occur more often in patients operated on for partial rupture of the Achilles tendon. In our study, the overall complication rate was 19%, and delayed wound healing was the most common problem; the entire rate of skin complications was 14%. The complications seemed to be more common in patients operated on for Achilles tendinopathy with peritendinous adhesions and intratendinous lesion (27%) than in those with peritendinous adhesions only (6%). One reason for the increased risk of complications after surgical treatment of the intratendinous lesion may be extensive thickening of the Achilles tendon followed by abnormal stretching and impaired local circulation of the skin. Also, the more extensive surgery and consequent tissue manipulation may increase the risk of complications.

In many previous studies, surgery for Achilles tendon overuse injuries has given satisfactory (70–95%) results. However, most of these studies were retrospective,^{6 12–14 23–28} and in only a few were the results based on objective evaluations, such as range of motion of the ankle.^{16 17 29}

To our knowledge there have only been three prospective studies on surgical treatment of the Achilles tendinopathy.^{18 30 31} Alfredson *et al*³⁰ evaluated prospectively the effect of surgical treatment on isokinetic calf muscle strength in 13 patients with various types of Achilles tendon overuse injury. They found that six months of rehabilitation after surgical treatment was not enough to restore concentric and

eccentric plantar flexion muscle strength to that of the uninjured side. A problem in their study design was that the surgery was followed by a relatively long (six weeks) immobilisation period in a plaster cast, although muscle tissue is known to be very sensitive to atrophy even after shorter (one week) periods of disuse, and its rehabilitation to normal function and volume is known to be one of the most difficult, tedious, and time consuming tasks, even in sports medicine.³² However, in a more recent study, Alfredson *et al*³¹ found no obvious advantages in recovery of isokinetic concentric and eccentric plantar flexion muscle strength of 11 patients with chronic tendinosis by using a shorter immobilisation time (two weeks).

Maffulli *et al*¹⁸ evaluated the results of percutaneous longitudinal tenotomy in 52 middle and long distance runners with unilateral Achilles tendinopathy (peritendinitis and/or intratendinous lesion) on the basis of isometric strength, endurance measurements, and subjective evaluation (six and 18 months after the operation respectively). They found that the presence of peritendinitis was a poor prognostic factor, the patients with tendinopathy associated with peritendinitis being less satisfied, less strong, and less resistant after the follow up period than patients with isolated tendinopathy (intratendinous pathology without peritendinous alterations at the ultrasonographic examination). In their surgical procedure, they did not trim the peritendinous adhesions, leaving the peritendinous tissues adherent to the Achilles tendon and surrounding structures. In our experience, all cases of Achilles tendinopathy with an intratendinous lesion show additional peritendinous adhesions, and we recommend that these adhesions are removed during the operation.

In the prospective non-controlled follow up study of Alfredson *et al*,³³ interesting preliminary results were obtained using an intensive muscle training regimen for chronic Achilles tendinosis. After the 12 week follow up period, all 15 patients were restored to their previous levels: full running activity; the pain during activity had decreased significantly; calf muscle strength on the injured side had increased significantly and did not differ significantly from that of the uninjured side. These preliminary results with important clinical implications have recently been reproduced in a randomised controlled study by Mafi *et al*.³⁴ They showed that the good clinical results with eccentric training in patients with chronic Achilles tendinosis were superior to treatment with concentric training.

In our study, the patients in group A fared better than those in group B when recovery of physical activity after surgery was evaluated (88% *v* 54%). This trend of better recovery in patients with peritendinous adhesions only was also found in the performance test on the lower limbs, although the group difference was not significant. Although the surgery was more extensive and the patients somewhat older in group B than in group A, one basic reason for a worse outcome in patients with a coexisting intratendinous lesion may be the more serious form of Achilles tendinopathy. Although the exact role of the intratendinous changes in the cause and pathogenesis of Achilles tendinopathy, related symptoms, and, in particular, treatment and prognosis of the patients is not known, we feel that imaging of the tendon structure with ultrasound or MRI may be beneficial when planning and timing surgical treatment for this condition. Also, the removal of the intratendinous lesion during surgery should be taken into account when planning a postoperative regimen and restarting sports specific training.

In addition to subjective evaluation, we observed clear improvements in the clinical tests and the performance test of the lower limbs. An important factor in these improvements may be the relief of pain after surgery. Our finding of improvement in the endurance of the calf muscles was in line with the results of a previous study of percutaneous longitudinal tenotomy for Achilles tendinopathy,¹⁸ although in

Take home message

Surgical treatment of Achilles tendinopathy gives good and acceptable short term results. A lower complication rate and a trend to better recovery was observed in patients with peritendinous adhesions only than in those with peritendinous adhesions combined with an intratendinous lesion.

that study there was still a slight difference between the injured and uninjured side six months after the operation. Longer follow ups are needed to see whether the above improvements in the function of the calf muscle-Achilles complex are indeed lasting.

In conclusion, this prospective follow up study showed that surgical treatment of Achilles tendinopathy gives good and acceptable short term results. A lower complication rate and a trend to better recovery was observed in patients with peritendinous adhesions only than in those with peritendinous adhesions combined with an intratendinous lesion. Randomised studies with a non-operative control group and longer follow up are needed to determine the true value of surgery in the treatment of chronic Achilles tendinopathy.

ACKNOWLEDGEMENTS

This work was supported by the Medical Research Fund of Tampere University Hospital, Tampere, Finland.

.....

Authors' affiliations

M Paavola, M Järvinen, Department of Surgery, Tampere University Hospital, Tampere, Finland

M Paavola, M Järvinen, Medical School and the Institute of Medical Technology, University of Tampere

M Paavola, P Kannus, M Pasanen, Accident and Trauma Research Center and the Tampere Research Center of Sports Medicine, UKK Institute, Tampere

S Orava, Mehiläinen Turku Hospital, Turku, Finland

REFERENCES

- Maffulli N, Khan KM, Poddu G. Overuse tendon conditions: time to change a confusing terminology. *Arthroscopy* 1998;**14**:840-3.
- Jozsa L, Kannus P. *Human tendons: anatomy, physiology, pathology*. Champaign, IL: Human Kinetics, 1997:1-574.
- Åström M, Rausing A. Chronic Achilles tendinopathy. A survey of surgical and histopathologic findings. *Clin Orthop* 1995;**316**:151-64.
- Clement DB, Taunton JE, Smart GW. Achilles tendinitis and peritendinitis: etiology and treatment. *Am J Sports Med* 1984;**12**:179-84.
- Kellett J. Acute soft tissue injuries: a review of the literature. *Med Sci Sports Exerc* 1986;**18**:489-500.
- Kvist M, Kvist M. The operative treatment of chronic calcaneal paratenonitis. *J Bone Joint Surg [Br]* 1980;**62**:353-7.
- Larsen AI, Egffjord M, Jelsdorff HM. Low-dose heparin in the treatment of calcaneal paratenonitis. *Scand J Rheum* 1987;**16**:47-51.
- Leach RE, Dilorio E, Harney RA. Pathologic hindfoot conditions in the athlete. *Clin Orthop* 1983;**177**:116-21.
- Rais O. Heparin treatment of peritendinomyositis (peritendinitis) crepitans acuta. A clinical and experimental study including the morphological changes in peritendon and muscle. *Acta Chir Scand Suppl* 1961;**268**:1-88.
- 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* 1987;**8**:298-303.
- Kvist M. Achilles tendon injuries in athletes. *Sports Med* 1994;**18**:173-201.
- Lehto MUK, Järvinen M, Suominen P. Chronic Achilles peritendinitis and retrocalcaneal bursitis. Long-term follow-up of surgically treated cases. *Knee Surg Sports Traumatol Arthrosc* 1994;**2**:182-5.
- Leppilähti J, Karpakka J, Gorra A, et al. Surgical treatment of overuse injuries to the Achilles tendon. *Clin J Sport Med* 1994;**4**:100-7.
- Nelen G, Martens M, Burssens A. Surgical treatment of chronic Achilles tendinitis. *Am J Sports Med* 1989;**17**:754-9.
- Paavola M, Kannus P, Paakkala T, et al. Long-term prognosis of patients with Achilles tendinopathy. An observational 8-year follow-up study. *Am J Sports Med* 2000;**28**:634-42.
- Schepisis AA, Leach RE. Surgical management of Achilles tendinitis. *Am J Sports Med* 1987;**15**:308-14.
- Schepisis AA, Wagner C, Leach RE. Surgical management of Achilles tendon overuse injuries. *Am J Sports Med* 1994;**22**:611-19.
- Maffulli N, Testa V, Capasso G, et al. Results of percutaneous longitudinal tenotomy for Achilles tendinopathy in middle- and long-distance runners. *Am J Sports Med* 1997;**25**:835-40.
- Testa V, Maffulli N, Capasso G, et al. Percutaneous longitudinal tenotomy in chronic Achilles tendonitis. *Bull Hosp Jt Dis* 1996;**54**:241-4.
- Kaikkonen A, Kannus P, Järvinen M. A performance test protocol and scoring scale for the evaluation of ankle injuries. *Am J Sports Med* 1994;**22**:462-9.
- Cetti R, Christensen S-E, Ejsted R, et al. Operative versus nonoperative treatment of Achilles tendon rupture. *Am J Sports Med* 1993;**21**:791-9.
- Paavola M, Orava S, Leppilähti J, et al. Chronic Achilles tendon overuse injury: complications after surgical treatment. An analysis of 432 consecutive patients. *Am J Sports Med* 2000;**28**:77-82.
- Fernandez-Palazzi F, Rivas S, Mujica P. Achilles tendinitis in ballet dancers. *Clin Orthop* 1990;**257**:257-61.
- Johnston E, Scranton P, Pfeffer GB. Chronic disorders of the Achilles tendon: results of conservative and surgical treatment. *Foot Ankle* 1997;**18**:570-4.
- Leach RE, Schepisis AA, Takai H. Long-term results of surgical management of Achilles tendinitis in runners. *Clin Orthop* 1992;**282**:208-12.
- Leppilähti J, Orava S, Karpakka J, et al. Overuse injuries of the Achilles tendon. *Ann Chir Gynaecol* 1991;**80**:202-7.
- Maffulli N, Binfield PM, Moore D, et al. Surgical decompression of chronic central core lesions of the Achilles tendon. *Am J Sports Med* 1999;**27**:47-52.
- Rolf C, Movin T. Etiology, histopathology, and outcome of surgery in achillodynia. *Foot Ankle Int* 1997;**18**:565-9.
- Morberg P, Jerre R, Swärd L, et al. Long-term results after surgical management of partial Achilles tendon ruptures. *Scand J Med Sci Sports* 1997;**7**:299-303.
- Alfredson H, Pietilä T, Lorenzon R. Chronic Achilles tendinitis and calf muscle strength. *Am J Sports Med* 1996;**24**:829-33.
- Alfredson H, Pietilä T, Öhberg L, et al. Achilles tendinosis and calf muscle strength. The effect of short-term immobilization after surgical treatment. *Am J Sports Med* 1998;**26**:166-71.
- Kannus P, Jozsa L, Renström P, et al. The effects of training, immobilization and remobilization on musculoskeletal tissue. *Scand J Med Sci Sports* 1992;**2**:100-18.
- Alfredson H, Pietilä T, Jonsson P, et al. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. *Am J Sports Med* 1998;**26**:360-6.
- Mafi N, Lorenzon R, Alfredson H. Superior short-term results with eccentric calf muscle training compared to concentric training in a randomized prospective multicenter study on patients with chronic Achilles tendinosis. *Knee Surg Sports Traumatol Arthrosc* 2001;**9**:42-7.