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## Chronic Achilles tendon pain treated with eccentric calf-muscle training

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**Abstract** Injuries involving the Achilles tendon and manifested as chronic tendon pain are common, especially among recreational athletes. In a pilot study on a small group of patients with chronic painful mid-portion Achilles tendinosis, eccentric calf-muscle training was shown to give good clinical results. The aim of this prospective study was to investigate if the previously achieved good clinical results could be reproduced in a larger group of patients, and also to investigate the effects of eccentric calf-muscle training in patients with chronic insertional Achilles tendon pain. Seventy-eight consecutive patients, having chronic painful Achilles tendinosis at the mid-portion (2–6 cm level) in a total of 101 tendons (55 unilateral and 23 bilateral), and thirty consecutive patients with chronic insertional Achilles tendon pain in 31 tendons (29 unilateral and one bilateral) were treated with eccentric calf-muscle training for 12 weeks. Most patients were recreational athletes. Evaluation of the amount of tendon pain during activ-

ity was recorded on a visual analogue scale (VAS), before and after treatment. In 90 of the 101 Achilles tendons (89%) with chronic painful mid-portion Achilles tendinosis, treatment was satisfactory and the patients were back on their pre-injury activity level after the 12-week training regimen. In these patients, the amount of pain during activity, registered on the VAS-scale (mean±SD), decreased significantly from 66.8±19.4 to 10.2±13.7. On the contrary, in only ten of the tendons (32%) with chronic insertional Achilles tendon pain was treatment satisfactory, with a significant decrease on the VAS-scale (mean±SD), from 68.3±7.0 to 13.3±13.2. Our conclusion is that treatment with eccentric calf-muscle training produced good clinical results in patients with chronic painful mid-portion Achilles tendinosis, but not in patients with chronic insertional Achilles tendon pain.

**Keywords** Achilles · Pain · Tendinosis · Eccentric training

### Introduction

So-called overuse injuries involving the Achilles tendon and manifested as chronic tendon pain are common among recreational athletes, especially in runners [5, 6, 14, 16, 21]. The majority of Achilles tendon overuse injuries occur in males, and in a higher incidence in middle aged athletes than most other overuse injuries [10].

The nomenclature used to describe chronic tendon disorders is confusing, the terms “tendinitis”, “tendinopathy”, “tenonitis” and “partial rupture” are often used by different authors to describe the same entity [4]. The nomenclature most often does not reflect the pathology of the tendon disorder [8, 13], and terms such as tendinitis and tendonitis are often used, even though there is no inflammatory cell infiltration in the tendon [8]. However, for a chronic painful condition in the tendon, with a gradual on-

set of pain, and where ultrasonography shows tendon changes in the mid-portion, it is now generally accepted to call this condition chronic Achilles tendinosis [8, 13].

In a study on sports related Achilles tendon injuries in Finland (1976–1986), 66% of the cases were described as paratenonitis including tendinopathies, while 23% of the cases were insertional pains [9]. Insertional complaints have been considered to be characterized by either bursitis in the retrocalcaneal and/or subcutaneous bursa, or by painful conditions of the tendon insertion [7]. No inflammatory cell reaction has been detected at the attachment, but tendinosis in the distal part of the Achilles tendon is a frequent finding [2, 13].

Distal Achilles tendon pain might also be associated with Haglund's deformity, which is characterized clinically by a tender swelling in the region of the Achilles tendon insertion, with a visible prominence most often localized at the posterolateral aspect of the calcaneus, probably causing an impingement [20].

Chronic Achilles tendon painful conditions, such as tendinosis, are well known to be difficult to treat [1, 10, 11, 13, 14, 16]. Conservative treatment is most often directed toward relieving symptoms [2], and surgery is chosen when conservative treatment has failed. However, there is a lack of prospective randomized studies comparing operative and conservative treatment of Achilles tendinopathy, and most of our knowledge on treatment efficacy is based on clinical experience and descriptive studies [15].

Stanish et al. have suggested an exercise program with a combination of eccentric muscle training and stretching for the treatment of chronic tendinitis [18]. Silbernagel et al. [17] have described good results with eccentric overload training on patients with chronic Achilles tendon pain; however, the localization of the tendon pain was not specified.

In two studies on small groups of patients with chronic painful Achilles tendinosis located at the mid-portion (2–6 cm level) in the tendon, 12 weeks of painful eccentric calf-muscle training was shown to give good clinical results and a fast recovery of calf-muscle strength, and eccentric training provided superior results to conventional concentric training [3, 12].

The aim of this prospective study was to investigate if the previously shown good clinical results with eccentric

calf muscle training could be reproduced in a larger group of patients with chronic painful mid-portion tendinosis, and also to investigate the effects of eccentric training on a group of patients with chronic insertional Achilles tendon pain.

## Material and methods

Two patient groups were included. One group consisted of 78 consecutive patients (53 men and 25 women) with chronic painful Achilles tendinosis at the mid-portion of the tendon (2–6 cm from the tendon insertion). There were unilateral symptoms in 55 patients, and bilateral symptoms in 23 patients, giving a total of 101 Achilles tendons. All these patients had a gradually evolving painful condition in the Achilles tendon located at the mid-portion, with a duration of at least three months (mean 19.3 months; range 3–240 months). Most of the patients were recreational athletes involved in activities such as jogging or running (49%), walking (33%) or other sports activities (18%). In all cases, the diagnosis was based on clinical examination performed by the same orthopedic surgeon (H.A.), showing a painful nodular thickening of the Achilles tendon located at the 2–6 cm level from the tendon insertion. In 83 tendons the diagnosis was confirmed by ultrasonography, where the tendon changes were described as a local thickening of the tendon, irregular tendon structure with hypo-echoic areas and irregular fiber orientation.

The other group consisted of 30 consecutive patients (24 men and six women) with chronic insertional Achilles tendon pain (29 unilateral and one bilateral) in a total of 31 tendons. The patients in this group were recreational athletes involved in activities such as jogging and running (36%), walking (3%) or other sports activities (61%). There were three high-level competitive male long-distance runners in this group.

In all cases in this group there was a gradually evolving painful condition in the Achilles tendon insertion area, causing pain during tendon loading activity. The patients had a typical history of long duration of pain symptoms during activity (mean 19.3 months; range 6–180 months).

The diagnosis was based on clinical examination performed by the same orthopedic surgeon (H.A.) in all the cases. The typical clinical findings were defined as tenderness and a painful thickening in the Achilles tendon insertion area. Twenty-one of the tendons were also examined with ultrasonography ( $n=16$ ), MRI ( $n=1$ ) and/or X-ray ( $n=10$ ). These examinations showed a mixed pattern containing retrocalcaneal bursitis, distal Achilles tendinosis and Haglund's deformity.

In all cases in both groups, the condition caused pain during tendon loading that made the desired activity level impossible. All patients had previously been treated with rest. A majority of the symptomatic tendons had been treated with other different treat-

**Table 1** Basic characteristics of 132 Achilles tendons in 108 patients with chronic Achilles tendon pain

Variable	Chronic painful mid-portion tendinosis			Chronic insertional tendon pain		
	Tendons in males ( $n=68$ )	Tendons in females ( $n=33$ )	Total ( $n=101$ )	Tendons in males ( $n=25$ )	Tendons in females ( $n=6$ )	Total ( $n=31$ )
Patient age in years (mean±SD)	44.0±9.9	50.5±7.1	46.1±9.5	36.2±11.5	45.0±9.8	37.9±11.6
Body mass index – BMI (mean±SD)	25.5±3.4	26.9±3.7	26.0±3.6	25.7±3.7	29.7±6.8	26.5±4.6
Duration of symptoms in months (mean±SD)	21.4±33.5	14.9±13.0	19.2±28.6	31.2±43.2	35.0±42.3	32.0±42.4
Previous NSAID treatment (% of cases)	68%	64%	66%	84%	100%	87%
Previous local cortisone injection (% of cases)	6%	12%	8%	32%	33%	32%
Other previous treatment (% of cases)	44%	46%	45%	68%	17%	58%

ment regimens (NSAIDs, local cortisone injection, physiotherapy, and different types of training programs or orthotic treatment) without satisfactory effect on the Achilles tendon pain. All patients were referred to the Sports Medicine Unit at the University Hospital of Umeå for surgical treatment. Basic characteristics and previous treatment are shown in Table 1.

#### Eccentric training model

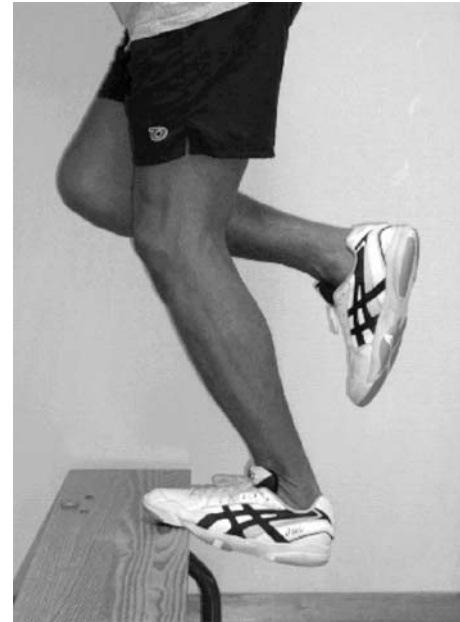
All patients were instructed on how to perform the eccentric training by the same physiotherapist (P.J.). They were given practice instruction and a written manual on how to progress. A control on how the patients did their exercises was done by the physiotherapist after six weeks. The patients were instructed to do their eccentric exercises two times daily, seven days/week, for 12 weeks. They were also given the advice to use a stable shoe when performing the exercises.

In the beginning, the loading consisted of the body weight. The patients were standing with all their body weight on their injured leg. From an upright body position and standing with all body weight on the forefoot, with the ankle joint in plantar flexion (Fig. 1), the calf-muscle was loaded by having the patient to lower the heel beneath the forefoot (Fig. 2). Two types of exercises were used. The calf-muscle was eccentrically loaded both with the knee straight (Fig. 3) and, to also maximize the activation of the soleus muscle, with the knee slightly bent (Figs. 1, 2). They were only loading the calf-muscle eccentrically; no following concentric loading was performed, as the patients were instructed to use the non-injured leg and/or the arms to get back to the start position.

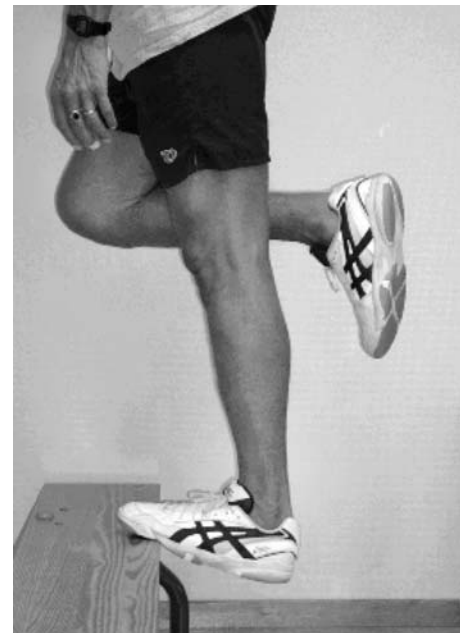
Each of the two exercises included 15 repetitions performed in three sets (3×15 repetitions). The patients were told that muscle soreness during the first one to two weeks of training was to be expected. The patients were told that the exercises were supposed to be painful, but to stop if the pain became disabling. When the patients could perform the eccentric loading without experiencing any minor pain or discomfort, they were instructed to increase the load on the tendon by using a backpack successively loaded with weight (Fig. 4) to reach another level of painful training. In this way the eccentric loading of the calf-muscle was gradually in-



**Fig. 1** Starting position, where the ankle joint is in plantar flexion. The knee is slightly bent



**Fig. 2** Eccentric loading of the calf-muscle with the knee slightly bent



**Fig. 3** Eccentric loading of the calf-muscle with the knee straight

creased. If very high weights were needed, the patients were told to use a weight-machine.

During the 12-week training regimen, walking and bicycling was allowed if it could be performed with only mild discomfort or pain. Light jogging on flat ground and at a slow pace was allowed after four to six weeks, if it could be done without pain. Thereafter their activities could be gradually increased if no severe pain in the tendon was felt.



**Fig. 4** Increasing the load by adding weight in a back-pack

#### Evaluation

The evaluation of the efficacy of the treatment regimen was focused on the possibility for the patients to return to previous (before injury) activity level. The amount of pain during activity was evaluated by the patients on a 100 mm-long pain-scale (VAS). On a VAS scale, the amount of pain is recorded from 0–100 mm, where no pain is recorded as 0, and severe pain is recorded as 100. The joggers registered the amount of pain during jogging, runners during running, and walkers during walking (i.e. registration depended on what type of activity the patients were engaged in). Evaluation was done before (week 0) and after (week 12) the eccentric training regimen. Patient satisfaction with the outcome of the treatment was estimated with an interview and a 100 mm-long

percentage scale, where not satisfied was recorded as 0% and full satisfaction as 100%.

#### Ethics

The study protocol for using this type of treatment method on patients with chronic Achilles tendon pain has been approved by the Ethical Committee of the Medical Faculty at the University of Umeå. All patients gave their consent to participate in this treatment model.

#### Statistical evaluation

The SPSS package (version 9.0, SPSS Inc., Chicago, IL, USA) was used for all frequency and statistical calculations. The results are expressed as mean±SD throughout the text. Differences within the groups were calculated with a non-parametric test for independent samples (Mann-Whitney U-test). Differences in estimated pain before and after treatment were calculated with a non-parametric test for paired samples (Wilcoxon signed ranks test). A p-value less than 0.05 was considered significant.

## Results

There were no drop-outs. All patients declared that they had performed the 12-week treatment regimen as prescribed.

### Chronic painful mid-portion Achilles tendinosis

In the group with chronic Achilles tendinosis at the mid-portion, treatment was regarded as good in 90 of the 101 painful Achilles tendons. These patients managed to return to pre-injury activity level after the 12-week training regimen. Their amount of pain during activity before the treatment (week 0) was 66.8±19.4, and after the 12-week training regimen it was 10.2±13.7. The difference in VAS-scale before and after treatment was highly significant ( $p < 0.001$ ) in both men and women. Evaluation of patient's satisfaction with treatment showed that the estimated percent of satisfaction with treatment was 83.3±17.3.

In ten patients, (seven women and three men) the results of the training regimen were not satisfactory. Six of

**Table 2** Basic characteristics and results after the eccentric training regimen in 132 Achilles tendons in 108 patients with chronic Achilles tendon pain – a comparison between the tendons with good and poor results

Variable	Chronic painful mid-portion tendinosis			Chronic insertional tendon pain		
	Good results (n=90)	Poor results (n=11)	P	Good results (n=10)	Poor results (n=21)	P
Patient age in years (mean±SD)	46.0±9.6	47.2±9.2	n.s.	41.2±11.1	36.3±11.8	n.s.
Male/female (%)	72/28	27/73	<0.05	80/20	81/19	n.s.
Body mass index – BMI (mean±SD)	25.7±3.6	27.9±2.5	<0.01	24.5±2.0	27.5±5.2	<0.05
Duration of symptoms in months (mean±SD)	19.8±29.9	15.1±12.7	n.s.	25.1±34.6	35.2±46.1	n.s.
VAS during activity week 0 (mean±SD)	66.8±19.4	74.0±18.9	n.s.	68.3±7.0	79.5±11.2	<0.01
VAS during activity week 12 (mean±SD)	10.2±13.7	64.9±26.4	<0.001	13.3±13.2	75.4±11.2	<0.001
Estimated subjective recovery in % (mean±SD)	83.3±17.3	12.9±23.7	<0.001	77.9±17.6	4.8±8.9	<0.001

the patients had unilateral symptoms, three patients had bilateral symptoms with satisfactory results on one side, but not on the other side, and one patient with bilateral symptoms had no satisfactory results at all. The amount of pain during activity before the treatment (week 0) was  $74.0 \pm 18.9$ , and after the 12-week training regimen it was  $64.9 \pm 26.4$ . These patients could not return to their previous activity levels and the results of their treatment were regarded as poor. Evaluation of patient satisfaction with the treatment in these cases showed that estimated percent of satisfaction with treatment was  $12.9 \pm 23.7$ . A comparison between the 90 tendons with good results and the 11 tendons with poor results is shown in Table 2. There was a significantly higher frequency of women and a higher body mass index (BMI) in the group with poor results. The 11 tendons with poor results were treated surgically.

In all cases, there were no injuries associated with the eccentric exercises. One of the patients recorded the Achilles tendon pain as being worse after than before the 12 weeks of treatment.

#### Insertional Achilles tendon pain

In the group with insertional Achilles tendon pain, ten of the patients with unilateral symptoms (32% of all the treated tendons) had good results, i.e. the patients had managed to return to their pre-injury activity level after the 12-week training regimen. In these ten patients, the recorded amount of pain during activity on the VAS-scale was reduced significantly ( $p < 0.01$ ) from  $68.3 \pm 7.0$  before treatment to  $13.3 \pm 13.2$  after treatment. Evaluation of patient's satisfaction with the outcome of the treatment in these cases showed that the estimated percent of satisfaction was  $77.9 \pm 17.6$ .

In the other 21 Achilles tendons (68%) with insertional pain, the results were poor, i.e. the patients could not return to previous activity levels after the 12-week training regimen. In these cases, there was no significant difference in the estimated amount of pain during activity recorded on the VAS-scale before and after treatment. The value before treatment was  $79.5 \pm 11.2$ , and after treatment it was  $75.4 \pm 11.2$ . Evaluation of patient's satisfaction with the outcome of the treatment showed that the estimated percent of satisfaction in this group was  $4.8 \pm 8.9$ .

Body mass index (BMI) and estimated pain during activity week 0 were higher in the group with poor results (Table 2). The three high-level competitive long-distance runners were all in the group with poor results, and the patient with bilateral symptoms had poor results on both sides.

There were no injuries associated with the eccentric training. In four of the 21 cases with poor results, the patients recorded the pain during activity as being worse after the 12 weeks of training than before the training. All patients with poor results were treated surgically. In all these cases there were signs of distal Achilles tendinosis,

the retrocalcaneal and subcutaneous bursae were found to be chronically inflamed, and there were signs of impingement between the postero-superior part of the calcaneus and the Achilles tendon.

The patients with chronic insertional Achilles tendon pain were significantly younger [ $37.9 \pm 11.6$  vs  $46.1 \pm 9.5$  years ( $p < 0.001$ )] and had a longer history of pain [ $32.0 \pm 42.4$  months vs  $19.2 \pm 28.6$  months ( $p < 0.05$ )] than the patients with chronic painful tendinosis at the mid-portion of the Achilles tendon.

#### Discussion

The results of conservative treatment of chronic Achilles tendon pain have previously not always been encouraging. In this investigation, we have studied chronic painful Achilles tendon conditions in the mid-portion and in the insertion into the calcaneus. Patients referred to the clinic were given the same eccentric training regimen that previously has been shown to give good results on small groups of recreational athletes with chronic painful mid-portion Achilles tendinosis [3, 12].

In the group with chronic mid-portion Achilles tendinosis, there were patients of both sexes, in various ages, and with different activity levels, also including patients with a low activity level. Despite this large variation of the participants, the treatment results were comparably as good as the results shown previously [3]. In 89% of the tendons in our study, the eccentric training model was successful. Among the 11 tendons where treatment was not successful, significantly more patients were females, and body mass index was higher than the others. Whether a female gender and/or high body mass index seem to be predictors of poor response to treatment, and whether this is attributable to a more severe pathogenesis, poor compliance to treatment, or other factor(s), remains unresolved.

We cannot explain the mechanisms behind the good results with eccentric calf-muscle training on mid-portion tendinosis. The eccentric exercises used in this study are painful to perform, and it is interesting that a painful treatment regimen gives positive results on a painful tendon condition. In a previous multi-center study, where painful eccentric training was compared to painful concentric training, on patients with chronic mid-portion Achilles tendinosis [12], significantly better clinical results were demonstrated with eccentric training. Therefore it seems that eccentric, but not concentric loading of the tendon in some way affects the pain mechanisms associated with chronic mid-portion Achilles tendinosis. Theoretically, it might be an effect of increased Achilles tendon and calf-muscle strength, possibly also mediating a better shock-absorption, causing less tendon pain during normal loading. It might also be an effect of a lengthening of the musculo-tendinous system, and thereby less tendon loading, and less tendon pain. Also, it might be that the exercises induce an alter-

ation of the metabolic events involved in pain mechanisms in the tendon.

Investigations of the influence of eccentric training on the pain mechanisms associated with this condition are needed. If the pain mechanisms can be clarified, this treatment could possibly also be used on other tendons with painful chronic tendinosis, such as the patellar tendon, the extensor carpi radialis brevis tendon of the elbow, and the supraspinatus tendon in the shoulder. A recent study on eccentric training as a treatment for lateral humeral epicondylalgia showed promising results [19], though the training program also consisted of other therapeutic modalities.

In the group with chronic insertional Achilles tendon pain, the results were not as good as in the group with mid-portion tendinosis. The eccentric training gave satisfactory results, permitting the patients to return to their previous activity levels, in only ten out of 31 tendons (32%). In the other 21 Achilles tendons (68%), the eccentric training regimen was not successful, and in four patients the pain became worse in response to the training. All the 21 tendons with poor results from the eccentric treatment regimen were treated surgically. Surgery revealed a mixture of pathologic findings. Therefore, theoretically, there are different possible sources for the pain (tendon, bursae and bone) that alone, or together, could cause the painful condition.

In 32% of the cases with insertional pain, the eccentric training had satisfactory results. We cannot explain why there was a good response to the treatment regimen in these cases. It could be a placebo effect, but theoretically, it might be that in these cases most of the pain was related to tendinotic tendon changes, responding to eccentric loading, and not to bursae/bone pathology. Importantly, in a majority of the tendons with distal pain the training regimen was not suc-

cessful. This could possibly be explained by the fact that the eccentric training could hardly have any positive effects on a mechanical problem, where the calcaneal bone impinges with a chronically inflamed bursae and/or tendon.

There were more high-level athletes and fewer patients with a low activity level in the group with insertional problems. There was also a higher frequency of patients previously treated with cortisone injection, probably due to clinical signs of bursitis. It is possible that the patients in the group with insertional pain had been training more vigorously and had subjected their Achilles tendons to more stress than the other group. However, we still don't know the aetiology to the conditions.

In this study, the evaluation of the treatment regimen was focused on the possibility for the patients to come back to previous (before injury) activity level. We did not use multiple types of functional test, because it is our opinion that the major endpoint for the patient is to be able to participate in his/her desired sports/recreational activities. From clinical praxis, it is well known that even though patients score very well on functional tests, they might still be unable to be fully active in their sport. Therefore, the sincere value of using multiple functional tests when evaluating results of treatment and rehabilitation is in our opinion questionable. A main goal for the treatment must always be the possibility to return to the previous activity level.

In conclusion, treatment with eccentric calf muscle training can be recommended for patients with chronic painful mid-portion Achilles tendinosis. The training is easy to perform, can be done at home, is not associated with any cost, and we have not seen any complications to treatment. On the contrary, in patients with chronic insertional Achilles tendon pain eccentric calf-muscle training was shown not to give good clinical results.

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