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Chronic Achilles Tendinopathy Treated With Eccentric Stretching Program

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ABSTRACT

Background: **This study assessed the efficacy of a modified eccentric heel-drop program (reduced time and increased duration of stretch) in treating chronic Achilles tendinopathy.** ***Methods:*** **Athletes with at least 12 weeks of symptoms diagnosed clinically as chronic Achilles tendinopathy were enrolled in the study. The only treatment recommended was a 6-week eccentric stretching regimen, with each stretch being maintained for at least 15 seconds. Athletes were followed to assess the response to treatment using a Visual Analogue Scale (VAS) for pain and a patient effectiveness rating for treatment satisfaction as well as time to return to pre-injury activity level. Followup was successful in 156 (82%) of the athletes. A total of 190 athletes were seen with chronic Achilles tendinopathy.** ***Results:*** **Mid-substance injuries were diagnosed in 168 (88%) with the remainder 22 (12%) having distal insertional injuries. Pain as assessed by VAS reduced from mean of 7.2 at commencement of the regimen to 2.9 ($p < 0.01$) after 6 weeks of stretching. Six months post commencement of program mean pain was 1.1. Patient satisfaction was rated at 7 or above (excellent) in 124 (80%) of the athletes. For mid-substance injuries the satisfaction rating was excellent in 86%. Overall mean time to return to pre-morbid activity was 10 weeks.** ***Conclusion:*** **A modified 6-week eccentric heel-drop training regimen as the only treatment for chronic Achilles tendinopathy resulted in a high degree of patient satisfaction, reduced pain and a successful return to pre-morbid activity levels. These results were best for mid-substance rather than insertional tendinopathy.**

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INTRODUCTION

Achilles tendinopathy is a difficult clinical problem that generally occurs as an overuse injury affecting middle-aged athletes, in particular runners and walkers.[2,5] Although diagnosis is relatively straightforward and best made on history and clinical examination, treatment can be prolonged.[12] Studies have demonstrated the effectiveness of eccentric stretching of the Achilles tendon for this condition. In these studies eccentric stretching generally refers to the patient undertaking heel drops, in effect the patients stretch and load the calf muscle (Figure 1).

Recommendations for eccentric exercise to be instituted for the treatment of Achilles tendinopathy have existed since the mid-1980's.[25] The first study on an eccentric stretching program for Achilles tendinopathy demonstrated effectiveness in all 15 subjects with mid-substance Achilles tendinopathy of prolonged duration,[1] where study subjects were required to do eccentric (lengthening) stretches for 12 weeks at a frequency of 90 stretches per session, twice daily. Success was judged with the subject having a decrease in pain as judged by improvement in their Visual Analogue Scale (VAS) scores and by their return to pre-injury activity levels at 24 weeks post-exercise commencement. Using a similar regimen, another study demonstrated an efficacy of 89%.[7] Other studies randomized eccentric exercise against control groups and these demonstrated the effectiveness of the eccentric exercise regime.[14,16,21,23] These aforementioned studies had total numbers in the study, including intervention and controls, ranging from 38 to 48.

When studies are analyzed that compare an eccentric training regimen for Achilles tendinopathy with another treatment modality, the beneficial effects of the eccentric training are substantial (73% in 40 patients,[28] 58% in 34 patients,[21] and 60% of 40 patients[13]). Due to the effectiveness of the eccentric exercise regimen, it is difficult

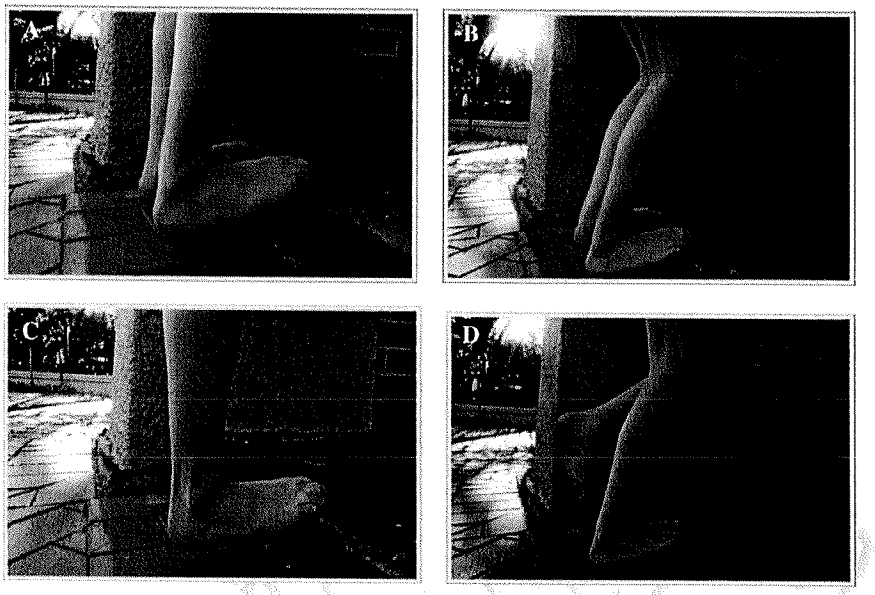

Fig. 1: The four exercises used in this eccentric "heel-drop" stretch for chronic Achilles tendinopathy. A. Weight on both legs, knees straight, B. Weight on both legs, knees bent to about 20 degrees, C. Weight on single leg, knees straight, D. Weight on single leg, knees bent to about 20 degrees.

for any "other" treatment to demonstrate a statistically significant advantage over the eccentric exercise regimen. Other treatments include the use of prolotherapy,[28] shock-wave treatment,[20] adjuvant use of night splints,[6] adjuvant use of air-heel brace[9,19] and therapeutic ultrasound.[3] A recent review concluded that due to the low cost and low risk, an eccentric stretching regimen should be first line treatment for Achilles tendinopathy.[15]

In all these aforementioned studies the eccentric training was performed by loading into ankle dorsiflexion. However, no time frame for remaining in the loaded dorsiflexed position was specified. Similarly, there is no consensus on the optimum dose of eccentric exercise nor is there a recommended exercise regime progression.[17]

Although eccentric stretching of the Achilles has been demonstrated to be effective in the treatment of mid-substance Achilles tendinopathy, there are limited studies looking at the results of eccentric training on insertional tendinopathy. Insertional tendinopathy is generally considered to be a different clinical entity to mid-substance Achilles tendinopathy.[4] A recent study demonstrated an effectiveness of 67% where eccentric training was performed without loading into dorsiflexion.[8] Other studies have not been as successful using the typical eccentric loading into dorsiflexion with successful results around 30%.[7,22]

The aim of this study was to look at the results of an eccentric stretching heel drop program, on a large number of consecutive patients with Achilles tendinopathy, both mid-substance and insertional. The eccentric program to be used involved a dorsiflexion stretch of longer duration (the stretch being held for 15 to 20 seconds) and to be completed in a shorter time period (6 weeks) compared to more standard eccentric treatment regimes. Part of this study assessed whether changes to the traditional eccentric program had any effect on the efficacy of the treatment.

MATERIALS AND METHODS

Patients presenting for assessment and treatment of Achilles tendinopathy to a primary care single sports medicine physician over 4 years were enrolled in the study. All patients presented with at least 12 weeks of pain associated with activity and had associated morning stiffness. The age, sex, and principal sporting activity of all subjects were recorded.

A total of 190 patients (mean age, 39; males 108 (57%), females 82 (43%)) were registered for the study. Successful followup was established in 156 (82%) of patients. No bias in this group for age, sex, or whether they had ceased activity or not was demonstrated. However, 142 out of 168 (84%) of the mid-substance Achilles tendinopathy were followed up successfully, whereas only 14 out of 22 (63%) of insertional Achilles tendinopathy were followed up successfully.

Participants were assessed for duration of symptoms and whether they had ceased sporting activity. Subjects were also asked to rate their maximum pain on activity (or after completion of an activity) using a Visual Analogue Scale. This scale was represented as 0 being no pain and 10 being the worst pain possible. Clinical assessment then followed for the following presence or absence of: 1) tenderness on palpation and 2) visible swelling of the mid-substance of the Achilles tendon. The location of the site of maximal

tenderness (mid-substance and/or tendon insertion) was also recorded.

Insertional Achilles tendinopathy was recorded if the patient had localized tenderness of the Achilles tendon insertion into the calcaneus located in the first 2 cm of the tendon. Mid-substance Achilles tendinopathy was recorded if the patient had localized tenderness only of the Achilles tendon 2 to 6 cm from the calcaneal insertion. The presence or absence of mid-substance swelling was noted and recorded.

Each participant then underwent a standardized rehabilitation program of eccentric exercises (heel drops) for treatment of the Achilles tendinopathy. A copy of the handout sheet given to the patient is attached (Appendix 1). All patients were shown the exercise regime. Emphasis was made regarding: 1) the eccentric stretch needed to be maintained for 15 to 20 seconds, 2) the patient needed to undertake the program for 6 weeks, 3) the patient was to try and return to their preferred activity/sport after completing 6 weeks of stretching irrespective of whether they thought they had improved or not and 4) patients were encouraged to continue the exercise regime at Level 4 (Appendix 1) after they had returned to sports/activity participation. All other treatments, if the patient was undertaking any, were ceased at time of enrollment. The diagnosis was based on history and examination findings.

Institutional ethics approval was obtained. Patients were assessed at 2 weeks (some patients), 6 weeks (some), 12 weeks (all), and 6 to 14 months (all) post-treatment commencement. Assessments at 2 and 6 weeks post-treatment were only performed if desired by the patient. These assessments were performed to enable the patient to complete the required regime and to progress the exercises, if necessary. If after completing the 6 weeks of exercises (and successfully obtaining Level 6 exercises for a period of at least 2 weeks (Appendix 1)) patients were unable to return to their physical activity, they were given a further 6 weeks of eccentric exercises. This treatment regime was the same as the original exercise series except the patient added an additional 40 kg of weight, placed in a backpack that the patient could wear.

All participants were assessed at 12 weeks after starting treatment. At this assessment patients were required to record their pain with activity again on a maximum pain with or after activity using a VAS. VAS scores were compared pre- and post-treatment with a Wilcoxon signed ranked test. The significance level was established at a p value of less than 0.05. Compliance was also assessed by a direct question as to whether they completed the exercise regime as set out in Appendix 1. Patients who stated they were not compliant for the given regime were asked for a reason for ceasing the regime during the prescribed time period. They were assessed as either: 1) pain worsening and/or perception the exercise regime was not working or 2) they believed the exercise regime had already been successful.

Assessment was made at 6 to 14 months post-treatment and was done by phone. At this assessment a VAS scale for pain in the Achilles tendon region during exercise was again performed. Wilcoxon signed ranked tests were used to assess the effectiveness of the treatment. In addition the patients were asked to grade the effectiveness of the treatment on a scale of 0 to 10, with 0 being totally ineffective and 10 being totally effective. Other outcome measures were whether the patient had undergone surgery subsequent to the treatment or whether the patient was still doing the eccentric exercises.

The time from commencement of the treatment program to a return to full activity was also questioned. This was done at the initial post-treatment 12-week assessment and the assessment 6 to 14 months post-treatment. A distinction was made between complete unrestricted activity and activity where the athlete still felt they had restriction due to some ongoing symptoms.

RESULTS

The principal sport was running/walking (57%). One hundred thirty-seven (72%) had ceased activity when assessed and the mean duration of symptoms was 18 (range, 12 to 104) weeks. Mid-substance Achilles tendinopathy was diagnosed in 168 (88%) and insertional Achilles tendinopathy in the remaining 22 (12%). Of the mid-substance Achilles tendinopathy, 121 out of 142 of those followed (85%) had noticeable tendon swelling, whereas 21 out of 142 (15%) had no swelling detected.

Of the 156 who were followed, 155 (99%) stated they commenced the eccentric stretching program, with 134 out of 156 (86%) completing the entire 6-week program. Of the 22 that did not complete the program, 12 ceased due to perceived program failure whereas the other 10 ceased the program as the perceived the program had been successful prior to completion of the 6-week program. At 6 to 14 months post-treatment commencement, 101 out of 156 (65%) were still undertaking the stretching program. All of these considered the program to be successful. Fifteen out of 156 (12%) were assessed at 6 weeks and required heavier load eccentric training using the program as described in the method. All of these were assessed at 12 weeks post-treatment commencement along with other subjects.

The mean VAS prior to treatment was 7.3 (median, 7). By 12 weeks post-treatment, this had reduced to 2.9 (median, 2) ($p < 0.01$ on original VAS score), and 6 to 14 months post-treatment this had further reduced to 1.1 (median, 0) ($p < 0.01$ on original VAS score).

Rated at 6 to 14 months post-exercise regime commencement, the mean score of treatment effectiveness rating was 7.8 (median, 9). It was rated 7 or above in 124 out of 156 (80%). Achilles tendon surgery had been performed in 7 out of 156 (4%) 6 to 14 months later.

The different categories of injury are presented in Table 1. These categories include mid-substance Achilles

Table 1: Number, Visual Analogue Scale (VAS) Rating Prior to Treatment, VAS Scale 12 Weeks Post-Treatment, Patient Effectiveness at 6–14 Months Post-Treatment, Patient Effectiveness Rating of 7 or Greater Out of 10, Achilles Tendon Surgery Within Last 14 Months

Achilles Tendinopathy	Insertional	Mid Substance not swollen	Mid substance swollen	Overall
Number	14 (9%)	21 (13%)	121 (78%)	156 (100%)
VAS rating prior to treatment	7.3	6.9	7.3	7.3
VAS rating post treatment	3	3.6	2.8	2.9
Patient effectiveness rating	6.5	6.9	8.0	7.8
Number with Patient effectiveness rating 7 or greater	7 (50%)	10 (48%)	106 (86%)	123 (80%)
Surgery within 14 months	3 (21%)	3 (14%)	1 (1%)	7 (4%)

VAS, Visual Analogue Scale.

tendinopathy with detectable tendon swelling tendon, mid-substance Achilles tendinopathy without detectable tendon swelling and insertional Achilles tendinopathy. The etiology of the injuries with mid-substance Achilles pain with tenderness but without any detectable swelling was unclear. It was unlikely they were early stage problems as the patient had to have had pain for at least 12 weeks before being recruited for this study. As they appeared to respond to eccentric training in a manner similar to insertional tendinopathy it was entirely possible they had been misclassified and should have been included in the insertional tendon group.

Table 1 demonstrates that mid-substance Achilles tendinopathy with detectable tendon swelling did significantly better in terms of reduced VAS score post-treatment and had a higher patient effectiveness rating when compared to the other two groups. Subjects with insertional tendinopathy had similar scores and effectiveness ratings to mid-substance Achilles tendinopathy where no tendon swelling was detected.

One hundred five subjects out of 156 (67%) had resumed unrestricted activity with a further 21 (13%) resuming full activity but with some ongoing symptoms. The mean time to return to full activity for 126 out of 156 (80%) was 10 (range, 2 to 26) weeks. Of the other 30 (20%) of subjects, seven had surgery, whereas 23 felt they had ongoing restriction that precluded full activity.

DISCUSSION

This study demonstrated that undertaking a modified, compared to traditional, eccentric heel drop treatment for Achilles tendinopathy with loading with body weight for at least 15 to 20 seconds and for a dose period of 6 weeks resulted in a substantial decrease in pain and a high patient effectiveness rating of 7 or greater out of 10 in 80% of all subjects. It should be noted that 12% of the athletes required 12 weeks of the stretching program before it was judged a success.

In looking at the sub categories of Achilles tendinopathy, it is readily apparent that the best results were obtained in those subjects with mid-substance tendinopathy that had clinically detectable swelling with this group rating the program 7 out of 10 in 86% of subjects. The results of the treatment for the other two groups, insertional tendinopathy and mid-substance tendinopathy without clinically detectable swelling could only be rated fair-to-good. This probably reflects the heterogenous nature of pathology at the posterior heel.

This study was consistent with the main premise of a recent review[15] that an eccentric stretching/loading regimen should be first line treatment for Achilles tendiopathy. Mid-substance Achilles tendinopathy with detectable swelling had the best results. A conservative eccentric stretch/load program for Achilles tendinopathy, either insertional or mid-substance without detectable swelling, may also be warranted as a treatment regime initially as the patient effectiveness of the program was rated 7 or greater out of 10 in approximately 50% of subjects along with a notable decrease in maximal pain measured during or after activity.

This study differed from previous eccentric loading programs that have been used for Achilles tendinopathy in the following ways: 1) Larger numbers; previous studies range from 15 to 67 subjects, 2) Insertional tendinopathy subjects were included, 3) Mid-substance Achilles tendinopathy patients were classified by whether the tendon had detectable swelling or not, 4) a decrease in the time commitment to the program (6 weeks) compared to the usual 12 weeks and 5) the length of the stretch (at least 15 seconds) was a notable difference from other programs.

It has been shown that when undertaking muscle stretching regimes, the optimum time for fiber modification (lengthening) is at least 15 seconds. It is thought that as the muscle stretch is held there is a decrease in tension thus allowing the muscle bridge filaments to set to a longer length.[26] However,

at the mechanistic level the reasons for this are not entirely clear.

One of the current theories of how eccentric training may help in chronic Achilles tendinopathy is by the exercise stimulating increased Type 1 collagen synthesis thereby helping repair the damaged tendon. A demonstrated increase in Type 1 collagen post eccentric training regimen for chronic Achilles tendinopathy has been shown in a recent study.[11] It is hypothesized that the overuse injury of Achilles tendinopathy is a result of a mechanical mismatch between mechanical loading and collagen fiber adaptation. Thus, in eccentric exercise regimens it is considered that this form of mechanical loading stimulates collagen formation and repair/regeneration. The purpose of holding the stretch for at least 15 seconds was that this may result in a greater stimulus for collagen synthesis compared to a stretching regimen with a smaller time duration holding the stretch. However a recent study has demonstrated that tendon stretching directly activates intracellular signalling pathways[24] and, furthermore, the longer the stretch, the more stress tolerance the tendon will develop, and in this respect tendon responds in a similar manner to stretch as does skeletal muscle, and is associated with a decrease in the apoptotic rate in human tendon fibroblasts.[24] In the case of tendons the stress tolerance developed may be more due to a change in tendon viscosity rather than elasticity.[10] Finally it has been demonstrated that increasing the magnitude of the stretch increases the production of Type 1 collagen in a stretching-magnitude-dependent manner.[27]

An interesting study[18] demonstrated that when a group of subjects with Achilles tendinopathy performed a loaded stretch in an elongated muscle position (the traditional eccentric stretch used for the treatment of chronic Achilles tendinopathy) and were compared to subjects who performed an unloaded stretch in an elongated muscle position and maintained for 30 seconds, both groups had improvement in pain and symptoms following completion of the regime. Therefore, it is unclear when performing the stretch in an elongated muscle position, whether it is the load or the duration of the stretch that is responsible for the effectiveness of the "eccentric" regimes. It may be that synergism can be obtained with the combination of both the load and the length of duration of the stretch.

We were surprised with the comparable results between the insertional group and the group with mid-substance Achilles tendinopathy without detectable swelling. Explanations for this include either the original mid-substance diagnosis was incorrect, and/or there was another pathology/problem of those athletes with mid-substance Achilles tendinopathy without detectable swelling when compared to their swollen counterparts. Thus, in effect, there may be three distinct entities in chronic Achilles tendinopathy.

This study has a number of weaknesses, which include: 1) The principal measure of patient effectiveness rating was performed in a retrospective manner and thus may not be a reliable measure, 2) No control groups were used so these results cannot be compared to another treated, or untreated, group, 3) There was a considerable time period between treatment initiation and final followup, 4) the subjects performed the exercises unsupervised without further instruction apart from the initial consultation (Appendix 1) and therefore we do not know whether they were performed in a consistent manner, 5) the diagnosis was made entirely on clinical grounds which is the traditional approach to diagnosis of this condition, and 6) Failure to use a recognized Achilles tendinopathy scale such as the VISA scale.

CONCLUSION

A 6-week eccentric training regimen with holding the stretch/load for at least 15 secs as the only treatment for chronic Achilles tendinopathy resulted in a high degree of patient satisfaction, reduced pain and a successful return to pre-morbid activity levels. These results were best for mid-substance when compared to insertional problems. This study reinforces the well established belief that eccentric heel-drop exercises can be the principal initial mode of treatment for the treatment of Achilles tendinopathy. Also,the efficacy of eccentric heel-drop exercises for the treatment of Achilles tendinopathy is maintained and may even improve with a reduced dose (decreased time of program −6 weeks compared to the traditional 12 weeks) but with an increased load (stretch/load held for at least 15 seconds per heel-drop).

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APPENDIX 1

Eccentric "heel-drop" program for chronic Achilles tendinopathy. All patients were given a written copy of this protocol.

Eccentric Stretching Program

Stretches Explained.

The stretch is called an eccentric step stretch.

Find a suitable step where you can stand upright (you should have no bend at your waist) with heels over the edge of the step (you should be on the balls of your feet) and lower yourself down over the step (you are allowed to use your hands to balance).

Each stretch should last 15 to 20 seconds. Tightness should be felt in calf not Achilles tendon. As a general rule I would encourage you to stretch irrespective of the pain that occurs DURING the stretch.

Number of Stretches

You do 6 stretches with knees straight and then 3 stretches with knees slightly bent.

This is 1 set. Weight will either be on both legs (Figures 1 and 3) or on one leg (Figures 2 and 4).

Program

Level 1: 1 Set with weight on both legs once per day

Level 2: 1 Set with weight on both legs twice per day

Level 3: 1 Set with weight on both legs three times per day

Level 4: 1 Set with weight on one leg (the affected leg) once per day

Level 5: 1 Set with weight on one leg twice per day

Level 6: 1 Set with weight on one leg three times per day

Minimum Number of days per Level

You should not progress to the next level unless

1. You have done three days in that level
2. You have not had any increase in morning after pain or stiffness OR you have not had increase in pain measured two hours after completing the last repetition for that day.
3. If you are unable to complete the program at any point is stop the program rest for 2 days and then resume at Level 1

How long do I do the program for?

6 weeks and then you return to running irrespective whether you consider whether you have improved or not.