Title: Acupuncture and eccentric overloading exercises in the treatment of chronic Achilles tendinopathy - A case study

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Vol. 17, No 1 (2014), Available at http://www.njmr.org.ng

Abstract

Background: Much has been written in the literature about the conservative management of Achilles tendinopathy. However, the effects of acupuncture treatment in combination with eccentric calf loading exercises appear not to have been extensively researched.

Objective: The objective of this study was to describe the effect of a treatment plan incorporating acupuncture and eccentric calf muscle stretching exercises on pain and functional improvements in the management of chronic Achilles tendinopathy using a single case study.

Methods: This is a single case report on a 35-year-old female runner with a two-month history of right ankle pain, at the back of the heel, following a 10km twice to thrice -weekly run. The main findings of the assessments were functional limitation due to pain when running, decreased range of movements in dorsiflexion and eversion movements in the right ankle and thickening of the right Achilles tendon. The treatment approach consisted of acupuncture with manual stimulation and eccentric calf training and ankle stretching exercises. The patient was treated twice weekly for six weeks. Outcome measures included Verbal Pain Rating scale (VRS) to assess pain, goniometer reading to measure movement and Patient Specific Functional Scale (PSFS) to assess functional limitation during activities of daily living (ADLs). Assessments were carried out at the beginning of treatment, after 6 weeks of treatment and at 1 and 4 month follow ups.

Results: The outcome of the study showed improvement with pain reduction from a VRS score of 7/10 in the first week to 0/10 after 4 months follow up. The results also showed increase in the active and passive range of movements in dorsiflexion and eversion from the first week of treatment (active dorsiflexion= 20^0, passive dorsiflexion =22^0, active eversion = $10^0$and passive eversion=15^0) to full recovery at follow-up periods. The PSFS scores at the pre-intervention,

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after six weeks, and at follow-up assessments were 12, 21and 28, respectively. The patient was able to run at least 10 km twice a week without pain and could stand up to walk from a prolonged sitting position without pain.

Conclusion: The outcome of this study has shown that acupuncture combined with eccentric calf muscle loading may be effective in the management of Achilles tendinopathy.

Key Words: Achilles tendinopathy, Acupuncture, Eccentric overloading exercises

Introduction

Achilles tendinopathy is a common condition, causing considerable morbidity in athletes and non-athletes alike. Achilles tendinopathy occurs in men and women of all age categories, but especially in men of middle age (Rompe, et al., 2007). The prevalence of the disorder is higher in sports that involve running or jumping (Peterson, Welp, and Rosenbaum, 2007). Remarkably, studies have shown that 33% of patients with chronic Achilles tendinopathy are not physically active, and that physical activity does not correlate with histopathological findings of the Achilles tendon (Holmes and Lin, 2006; Scott, Huisaman, and Khan, 2011). Physical load on the Achilles tendon should be more seriously considered as a factor that provokes the disorder and not as an etiological factor (Holmes and Lin, 2006).

The pathogenesis of tendinopathies remains unclear (Abate, et al., 2009). The terms "tendinitis" and "tendonitis" have been used, despite the absence of scientific evidence indicating inflammation (Alfredson, et al., 2007). Tendinopathies are described as tendinosis, which presents as disorientation of collagen, focal necrosis, and increased prominence of vascular spaces (van Sterkenburg and van Dijk, 2011). Although a conservative management approach is recommended, there is a considerable lack of evidence supporting a specific conservative management strategy. General treatment guidelines supported by the literature include methods to relieve pain, avoid re-aggravation, and treat injured tissues from the perspective of ameliorating angiofibroblastic degeneration and functional impairment (Magnussen, Dunn, and Thomson, 2009).

Conservative management, including physiotherapy, is accepted as first-line management of Achilles tendinopathy (Magnussen, Dunn, and Thomson, 2009); however, despite a growing volume of research, there remains a lack of high quality studies evaluating their efficacy.

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Although clinical research appears to support the efficacy of eccentric calf loading for the treatment of chronic Achilles tendinopathy, evidence regarding the mechanism of action is still unclear (Fu, et al., 2010; van Sterkenburg and van Dijk. 2011). Although the effects of eccentric training are promising for reducing pain in chronic Achilles tendinopathy, the full magnitude of its effect cannot be determined due to the lack of satisfactory methodological quality of the studies (Alfredson, et al., 2007; Kingma, et al., 2007)

The thickening of the tendon suggests pathological changes occur in the tendon, which is also suggestive of an underlying Achilles tendinopathy with or without acute inflammation (Cook and Purdam, 2008). Consequently, both an inflammatory and mechanical component should be considered and an appropriate rehabilitation enforced to reduce sensitization of the dorsal horn neurons within the spinal cord (Bradnam, 2007). Preliminary evidence of tendinopathy has attributed nociceptive inflammatory pain to unidentified biochemical noxious compounds such as glutamate, substance P, or calcitonin gene-related peptide (CGRP) (Ackermann, Salo, and Hart, 2009; Kubo, et al., 2010). Whether or not the inclusion of some other conservative therapy intervention in combination with eccentric training improves the prognosis has not been extensively researched. A literature review of studies on the prognosis of patients with chronic Achilles tendinopathy treated conservatively with acupuncture either alone or in combination with a regime of eccentric calf strengthening appeared to be scarce. The aim of the present study was to investigate, in a case study, changes in pain intensity and functional improvement of a patient with chronic Achilles tendinopathy following a treatment plan incorporating acupuncture and eccentric exercises.

Methods

Case Report

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The subject was a 35-year-old female runner who presented at the Physiotherapy Clinic, Occupational Health Department, Cummins Engine Inc, Daventry, UK, with a two-month history of right ankle pain following a 10km twice to thrice-weekly run. She also complained of reduced range of movements in the right ankle. She felt her symptoms had worsened gradually over the previous two weeks, particularly in the morning. She described that putting her heel to the floor, within the first few minutes of running, produced sharp pain, rated as 7/10 on Verbal Rating Scale (VRS). Running uphill and standing on tiptoes were other aggravating factors. Resting, ice treatment and ibuprofen were reported to have been used to alleviate the symptoms at the early stage prior to seeking physiotherapy treatment. Wearing antipronated running shoes produced some symptomatic relief. The patient also gave a past history of recurrent right ankle pain and loss of range of movement for 8 years that was not diagnosed or managed by medical and/or health professionals. The patient had no history of other medical and/or surgical conditions that could be linked to her present complaint. She neither experienced any neurological symptoms nor was taking any medication apart from ibuprofen, which she took when needed. An X-ray was not taken and other investigational tests were not performed.

Subjective Findings

On subjective examination, the patient reported the pain in the posterior aspect of the right ankle to be 7/10 on the VRS. She reported intermittent sharp pain when walking, particularly after prolonged sitting. She was able to bear weight throughout the period of examination. No pins and needles were reported. Yellow flag (psychosocial factors such as depression, anxiety, fear and avoidance) and red flag (evidence of serious spinal pathology, systemically unwell, and weight loss) conditions were ruled out.

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The Pain Specific Functional Scale (PSFS) questionnaire was used to assess functional limitation during difficult activities as a result of Achilles tendinopathy. PSFS has been reported to be useful in quantifying activity limitation and to measure functional outcomes for patients with any orthopaedic condition. The patient was asked to identify up to three important activities that she was unable to do or had difficulty with as a result of her ankle problem and also to rate the difficulty on a scale of 0 (unable to perform activity) to 10 (able to perform activity at the same level as before injury or problem). The test-retest reliability and sensitivity of PSFS to change were excellent with intraclass correlation coefficient of 0 .84 and Pearson's correlation coefficient of 0.78 (Stratford et al., 1995). The total score is calculated as a sum of the activity scores/number of activities. The minimum detectable change (90%CI) for average score was 2 points while the minimum detectable change (90%CI) for single activity score was 3 points (Stratford et al., 1995).

The functional limitation to activities identified by the patient on PSFS were pain with running, pain with walking uphill and pain with stretching of her right ankle planter flexors. The patient's main functional goal was to be able to run at least 10 km twice a week without pain and standing up from a prolonged sitting position to walk without pain.

Physical Examination

Objective Examination

Observation: Visual observation of the patient's feet in standing posture revealed mild external rotation of right foot with thickening of bilateral Achilles tendons (right>left). On visual inspection, the patient appeared to lean more onto the left lower limb than the right lower limb while in standing position. A visual analysis of the patient's barefoot running gait showed

antalgic gait on the right, decreased right heel strike, eversion of the right ankle and heavy landing on the left foot in mid stance.

Palpation: There was marked tenderness with a VRS of 5/10 and thickening of right Achilles tendon which measured 4cm (measurement was taken from a point 7cm to insertion) compared to the left which measured 3.5cm.. It is important that a correct diagnosis is formed to enable appropriate treatment in accordance to the pathology.

Achilles palpation test, which involves compression of the Achilles tendon between the second and fourth digits (Mafulli, Wong, and Almmekinders, 2003) elicited pain. The Arc Sign, which involves active plantar flexion and dorsiflexion while observing the Achilles tendon and noting if swelling remains static (absence of tendinopathy) or moves (presence of tendinopathy), was carried out and gave a positive result. These findings helped to support that the correct clinical diagnosis was Achilles tendinopathy (Mafulli, Wong, and Almmekinders, 2003). Small areas of local tenderness (trigger points) were also elicited on palpation within the medial head of the right gastrocnemius muscle. Increased muscle tension (tightness) of the right gastrocnemius was felt on palpation compared to the left side. The extensor retinaculum and tibialis anterior tendon were not tender to touch.

Movements

Goniometric measurements of active and passive movements of the right ankle were taken as described by Salsichi, Mueller, and Sharman (2000). Dorsiflexion was assessed with the patient in prone position, with the ankle off the edge of the table and the knee extended. The tibia was then manually stabilized against the supporting surface. The axis of movement was located at the lateral calcaneus at the bisection of the fibula and the 5^{th} metatarsal. The proximal arm of the goniometer was positioned parallel to the long axis of the fibula, pointing towards the fibular

head, while the distal arm was positioned parallel to the long axis of the 5th metatarsal. Plantarflexion was assessed with the patient in the supine position and the knee in slight flexion. Goniometric axis and placement of proximal and distal arms of the goniometer were the same for dorsiflexion. Inversion and eversion movements were taken with the patient seated on a plinth and without foot contact with the floor or any other support. The goniometric axis was located at a point just proximal to the Achilles tendon insertion on the calcaneus. The proximal arm of the goniometer was positioned parallel to the distal bisection of the lower leg while the distal arm was positioned parallel to the long axis of the 5th metatarsal (Salsichi, Mueller, and Sharman, 2000). The measurements were taken three times and the average recorded.

Special Tests

Evaluation for Achilles tendon rupture was done with the Thompson test (Mazzone and McCue, 2002) and was negative in this patient. Bilateral heel raise test carried out to assess the effect of Achilles tendinopathy on movement control showed reduced weight bearing on the right leg but the patient was able to achieve five repetitions before experiencing excruciating pain and fatigue. This movement was also characterized with poor control and excessive inversion of the right ankle. The anterior drawer sign and talar tilt were negative, indicating uninterrupted ankle ligaments. The Semmes-Weinstein monofilaments test was performed to assess the sensation of the foot and ankle (Mueller, et al., 1989). The result of this test showed that the sensation to pressure in the foot and ankle were intact. Supine straight leg raising was unremarkable for signs of nerve root tension. Clearing test as described by Petty and Moore (1998) was asymptomatic, and thus ruled out any form of pathology from the patient lumbar spine, sacroiliac joint, and hip and knee joints.

The main findings of the subjective and objective examinations were pain, reduced active and passive range of movements of dorsiflexion and eversion of the right ankle joint, and limitation in functional activities.

*Clinical Impression***:** Pain, reduced range of motion and limitation of functional activities in the right ankle due to Achilles tendinopathy were observed.

Aims of Treatment

The aim of the treatment was to reduce pain and increase range of active and passive movements of dorsiflexion and eversion of the right ankle joint, which would eventually lead to achievement of the patient's functional goal.

Management

The patient was treated twice weekly over a 6-week period and then seen and assessed at 1- and 4-month follow ups. The treatment began with slow eccentric calf lowering exercises with static gastrocnemius and soleus stretching followed by acupuncture treatment.

Eccentric Calf Muscle Exercises

The patient was in standing position with hands on the plinth to provide support and prevent swaying. She was instructed to stand on the toes of both feet, then to lift the affected foot off the floor and then lower the body down gently to the starting position only on the foot of the affected side. The exercise was repeated 20 times.

Static Gastrocnemius and Soleus Muscle Stretching

a) Gastrocnemius: The patient was in forward lunge standing position with the leg of the unaffected side in front and the affected leg behind and was instructed to keep the knee of the affected leg straight and keep lunging to the bent knee of the unaffected leg in the front until a stretch/discomfort is felt in the calf of the affected leg. The patient was

instructed to hold the stretch for 20 seconds and then repeat 5 times (Alfredson, et al., 2007).

b) Soleus muscles: The position and movement was the same as above but with the knee of the affected leg slightly bent as the patient lunged forward. The stretch should be felt lower down in the leg and very close to the Achilles tendon. The patient was instructed to hold the stretch for 20 seconds and repeat 5 times (Alfredson, et al., 2007).

Acupuncture Treatment

The patient was properly instructed on what to expect in terms of the acupuncture treatment, the possible side effects and contra indications to acupuncture treatment. The patient's informed consent was obtained prior to treatment. The patient was in a supine position, lying with proper pillow support under the head and neck and behind the knee joints for comfort. The patient received acupuncture treatment at selected acupuncture points for 20 minutes. The selected acupuncture points used in the present study, according to Roberstshawe (2009), are widely accepted for treating ankle and Achilles problems (Figures 1, 2, and 3), namely LI4 (highest point of the adductor pollicis muscle), BL62 (below lateral malleolus), and GB34 (at the point of intersection of lines from the anterior and inferior borders of the head of the fibula).

Figure 1: Insertion of acupuncture needle at LI 4

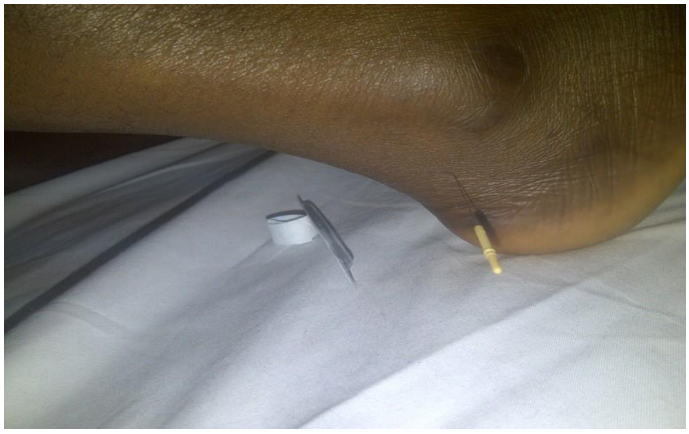

Figure 2: Insertion of acupunture needle at BL62

Figure 3: Insertion of acupuncture needle at GB 34

At each point, the skin was wiped with alcohol, and the therapist's hands were cleaned with alcohol gel prior to needle insertion. Disposable stainless steel needles (0.2mmx40mm, Seirin) were inserted into both sides of the Achilles tendon to a depth of 10mm using the sparrow pecking acupuncture technique (alternate pushing and pulling of the needle). When the subject felt dull pain or acupuncture sensation ('de qi': numbness, soreness and or radiating sensation), the needle manipulation was stopped, and the needle was left in position for another 20 minutes. The patient was also required to follow a specific protocol of home exercise program that included calf stretching and eccentric heel lowering exercises. The patient was instructed to maintain her current level of physical activity, but not to increase it.

Results

Table 1 shows the patient's active and passive range of motion profile. It shows steady increase in the range of movements from the first week to full recovery at the 4-month follow up. At the end of 6 weeks of intervention, the patient recorded full active range of movements in all directions in the right ankle joint, and there was no need to assess passive range of motion when active range of motion was full. Surprisingly the eversion range of motion of the right foot at the 6-week follow up was higher than the basal value for the left foot.

Table 1: Patient's Range of Motion (ROM) profile

Basal values of ankle joints active and passive range of motion				
	Active ROM		**Passive ROM**	
	Right	**Left**	**Right**	**Left**
Dorsiflexion				
Planterflexion	42^0	45^0	45^0	45^0
Inversion	25^0	30^0	30^0	32^0
Eversion	10^0	30^0	15^0	35^0
Right ankle active ROM profile at 6-week, 1-month and 4-month follow up				
	After 6 weeks of treatment	**1-month follow-up**	**6-month follow-up**	
Dorsiflexion	36^0	35^0	35^0	
Plantarflexion	45^0	45^0	45^0	
Inversion	30^0	33^0	33^0	
Eversion	32^0	35^0	35^0	

Table 2 shows the pain intensity and functional improvement profile. It shows a steady decline in the VRS scores from 7/10 in the first week to 0/10 at the 4-month follow up. Prior to treatment, difficulty with running, walking uphill and with stretching in the right ankle on PSFS were each rated as 4/10, and thus the patient had an average PSFS score of 4 (Table 2). However at the 4-month follow up assessment, PSFS scores were rated as 10 for each of running, walking uphill and stretching of the right ankle, with an average score of 10 (Table 2). The patient's main

functional goal of being able to run at least 10 km twice a week without pain and standing up to walk from a prolonged sitting position without pain was reportedly met.

Table 2: Pain intensity (VRS) scores and functional improvement profile

Functional improvement profile	First week of treatment	After 6weeks of treatment	1-month follow up	4-month follow up
VRS scores for walking uphill	7/10	2/10	0/10	0/10
VRS scores for calf stretching	5/10	2/10	0/10	0/10
VRS scores for pain intensity	7/10	2/10	1/10	0/10
PSFS Scores	4	7	7	10

Discussion

The patient reported more than 75% pain reduction and improvement in function after 6 weeks of treatment and further improvement with almost complete resolution of symptoms at 1-month follow up, which was maintained at the 4-month follow up. Thus it could be said that the case study has demonstrated that a combination of acupuncture and eccentric calf muscle stretching exercise is effective in reducing pain, increasing ankle range of motion and reducing functional activity limitations arising from Achilles tendinopathy.

The possible beneficial effects of using eccentric loading exercise in this study corroborates findings from previous studies (Chinn and Hertel, 2010; Wilson and Stacy, 2010). Chinn and Hertel (2010) used a conservative treatment approach that consisted of acupuncture and electrical stimulation, Graston Technique, eccentric calf training, and rehabilitative exercise prescription while Wilson and Stacy (2010) used a different treatment that consisted of shock wave therapy in the conservative management of Achilles tendinopathy. The findings of both studies indicated

that the patients attained long-term resolution of symptoms after treatment and at follow-up and reported no recurrence of symptoms. It appears there are not many studies on the effects of acupuncture treatment with or without other conservative treatment on Achilles tendinopathy in this environment.

Eccentric training has garnered considerable attention with respect to rehabilitation of Achilles tendinopathy. Studies have suggested that eccentric strength exercises for the calf can improve symptoms and should be initiated early in treatment (Mafi, Lorentzon, and Alfredson, 2001; Silbernagel, Brorsson, and Lundberg, 2010). It has been hypothesized that eccentric training may be beneficial because of its effect on improving microcirculation and peritendinous type I collagen synthesis (Knobloch, et al., 2006). Stretching exercises for the gastrocnemius-soleus complex have also been advocated to reduce pain and improve function (Sanders and Rathur, 2008), especially when stretching exercises and eccentric calf exercises for both the gastrocnemius and soleus muscle groups were initiated early and were well tolerated by the patient. Experimental and clinical trials have shown that acupuncture and electroacupuncture are beneficial in painful inflammatory and degenerative conditions (Deadman, Al-Khafaji, and Baker, 2007; Yim, Lee, and Hong, 2007).

Possible therapeutic effects of acupuncture could be linked to enhancing activation of A-δ and C afferent fibers in muscle during needle stimulation of acupuncture points. Thus, signals are transmitted to the spinal cord, and via afferent pathways, to the midbrain (Gamus, et al., 2008). The resulting flow and integration of this information among specific brain areas will lead to a change in the perception of pain via the descending pain modulatory system. The descending pain modulatory system is a key anatomical network that underlies the ability to change pain intensity. Acupuncture analgesia improved the noxious descending inhibitory controls and pain

gate mechanism and therefore helped to reduce the patients' pain levels (Yim, Lee, and Hong, 2007; Gamus, et al., 2008). The evidence for the mediation of acupuncture analgesia by endorphin is very strong, while that of the involvement of monoamines needs more work to verify the possible synergism of serotonin and norepinephrine (Yim, Lee, and Hong, 2007). The raphe magnus in the brainstem contains most of the serotonin cells in the brain and lesions that destroy these cells have been shown to impair acupuncture analgesia (Yim, Lee, and Hong, 2007). Despite several studies claiming the success of acupuncture in the treatment of inflammatory and degenerative disorders, the use of inflammatory/infectious animal models is essential for validating and increasing the knowledge of mechanisms involved in producing the effects of acupuncture therapy.

Conclusions

This study has found that acupuncture combined with calf muscle eccentric stretching could be effective in the treatment of Achilles tendinopathy.

Conflict of interest: None declared.

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