ORIGINAL RESEARCH

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The Limited Effectiveness of a Home-Based Eccentric Training for Treatment of Achilles Tendinopathy

Abstract

Purpose: Objective was to evaluate the outcome of a standardized heavy load eccentric training program in adults with chronic painful Achilles tendinopathy, and the presence of increased Colour Doppler activity in diseased and non-diseased adults. The hypothesis was that patient satisfaction would fall within the range of average satisfaction present in the literature (60 to 90%).

Methods: Twenty patients were instructed on a training program based on the Alfredson protocol of straight leg followed by bent knee heel drops and raises. Patient satisfaction was recorded as the primary outcome. Secondary outcomes included the VISA-A and Tegner scales. Twenty one subjects without present or history of lower extremity pain and seven patients presenting at the clinic but without Achilles tendinopathy were included as controls.

Results: Patient satisfaction was significantly lower when compared to the literature as two patients reported that they were satisfied with the treatment while the remaining 15 reported that they were unsatisfied. Three patients were excluded from the analysis as they were unable to complete the exercises. Increased Colour Doppler activity was present in only one participant without the disease and in all patients with the disease at the end of the study (increased Colour Doppler activity was present in 40% of patients with the disease at the beginning of the study).

Conclusion: Although some patients' symptoms improved over time, eccentric training did not satisfy patient expectations of improvement following treatment despite compliance with the home based program. Although it is a mainstay of treatment, other options, which are both efficacious and effective, need to be provided for patients who prefer a conservative and relatively non-invasive treatment option from the start.

Manuscript submitted 1st February, 2013

Manuscript accepted 7th July, 2013

Clin Invest Med 2013; 36 (4): E197-E206.

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Despite being one of the largest and strongest tendons in the human body, injuries frequently occur to the Achilles tendon [1-5]. The incidence of Achilles tendon injuries has increased over the past two decades. The prevalence of Achilles tendinopathy has been estimated at 7-18% in runners [1-5]. Lack of or weak evidentiary support for the use of non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, rest, ice, physical therapy and biomechanical alterations complicates treatment [6]. Previous studies suggest that somewhere between 24% and 44% of Achilles tendinopathy patients fail to improve with conservative management; requiring either significant activity modification or surgery [7, 8].

Eccentric training or loading protocols have increased in popularity following the results of successful randomized controlled trials that suggest patients perform them prior to other treatments [9-11]. A comparative study of the Alfredson heavy load eccentric training protocol required patients with chronic painful mid-portion Achilles tendinopathy to perform heavy load eccentric exercise on a daily basis for 12 weeks, while the control group performed concentric exercises [10]. In the eccentric group, 82% of patients were satisfied with treatment after 12 weeks, whereas only 36% were satisfied in the concentric group [10]. Similar results have been reported from studies involving eccentric exercises, both on their own and in combination with other modalities, with a success rate between 60% and 90% [11-14]. As a result, a treatment paradigm beginning with heavy load eccentric exercises has been suggested [15].

There is an absence of RCT/level 1 evidence with respect to the existing studies on this topic [16]. Eccentric exercises' success requires a high level of patient motivation and may not be suitable for elderly or frail patients [17]. Eccentrics may not have a similar benefit for mid-portion and insertional tendinopathy patients, although a recent uncontrolled and nonrandomised study suggested that chronic insertional tendinopathy patients may respond to specific eccentric loading exercises [18]. A study by Sayana and Maffulli (2007) also suggested that eccentric exercises have less promising results in sedentary individuals compared with active individuals [19].

Despite these limitations and the lack of information on its relation to pathology, eccentric exercises are still being suggested to patients with chronic Achilles tendinopathy. No studies have been performed to evaluate the effectiveness of a 12 week home-based heavy load eccentric training program for chronic painful Achilles tendinopathy in an unrestricted adult population; therefore, this study was undertaken as part of the initial phase of an RCT investigating treatment options for Achilles tendinopathy. The hypothesis was that patient satisfaction with treatment (home based heavy load eccentric training

program) would fall within the range of average satisfaction present in the literature of 60 to 90%. The second objective was to describe the effect of a standardized heavy load eccentric training program in adults with no prior history of Achilles tendon pain, specifically related to increased Colour Doppler activity (also referred to in some studies as neovascularisation), as no study to this point has determined if eccentrics themselves can cause increased Colour Doppler activity hypothesis was that increased Colour Doppler activity would not be present after conclusion of the program. The third objective was to explore the presence of increased Colour Doppler activity in adults with no previous lower extremity injuries presenting to a sports medicine clinic, as no study to this point has recorded whether increased Colour Doppler activity exist in non-injured individuals (hypothesis was that increased Colour Doppler activity would not be present in this population).

Methods

Study approval

The study was approved by, and carried out according to the instructions of, the authors' institutional Human Investigations or Ethics Committee. Ethical approval (ID 20903) was granted by the Conjoint Health Research Ethics Board at the University of Calgary on May 17, 2007.

Selection and Description of Participants

The study was part of the initial phase of a randomized controlled trial (protocol record UC-20903-RR). Convenience sampling, a non-probability sampling strategy, was employed. The "definition of condition" was history of Achilles tendon pain. Although numerous recruitment strategies were employed (requesting direct referrals from physicians, patients presenting at the Sport Medicine Centre at the University of Calgary, poster advertisements (in physicians' offices, fitness centres, universities and colleges), and an e-poster advertisement through the University of Calgary requesting participants with a history of Achilles tendon pain) all patients in the study ended up being recruited from the Sport Medicine Centre. Population with Achilles tendon pain was assessed using the inclusion and exclusion criteria (Table 1). Informed consent was asked of those participants that passed the inclusion/exclusion criteria. Participants who refused to enter the study were counselled regarding treatment options by the study sport medicine physician as per standard of care. Participants for whom informed consent was received were serially enrolled into the study until an *a priori* sample size for the RCT was reached ($n = 16$).

TABLE 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> - Adults 18 years of age and older with a minimum of 3 months of clinically determinant history and symptoms (pain) consistent with unilateral Achilles tendinopathy (insertional tendinopathy or mid-portion) as diagnosed by a sport medicine physician. - Participants are not required to have tried other treatments; however, those who have tried other treatments (except injection treatments) including, but not restricted to, oral NSAIDs, topical NSAIDs, shoe modifications, and physical/athletic therapy will not be restricted from the study - Provide informed consent for the controlled longitudinal study and RCT 	<ul style="list-style-type: none"> - Individuals with physical ailments precluding them from performing the eccentric training program - Worker's Compensation Board (WCB) and elite athletes (varsity, national and professional level) - Individuals younger than 18 years of age will be excluded from this trial due to the complicating factors of musculoskeletal immaturity and the lack of relevant research of Achilles tendinopathy and neovascular bundles in this population (218). - Previous Achilles tendon rupture of the tendon in question - Individuals that have received any type of injection in or around the Achilles tendon - Known allergy to dextrose based sclerosing agent or other contraindications - Known allergy to lidocaine

Data from studies using an eccentric training protocol reported 60-90% chance of success [11,12,14]. Using 80% as the assumed probability of success, to end up with 16 participants in the sclerosing therapy RCT who have failed a standardized eccentric training protocol up to 80 participants might be required; however, once 16 participants were enrolled in the RCT, recruitment of individuals with Achilles tendon pain stopped.

The second cohort of 21 graduate students without any current or prior lower extremity injuries were recruited once the final sample size of adults with chronic Achilles tendinopathy was established. Their purpose was to describe the effect of a standardized heavy load eccentric training program in adults with no prior history of Achilles tendon pain. To be included, they had to be adults, 18 years of age or older, they had to have no previous lower extremity injury (including no prior or current diagnosis of Achilles tendinopathy) and they had to be able to perform the eccentric exercises.

The final cohort recruited consisted of patients (with no known lower extremity injuries) presenting at the Sport Medicine Centre (SMC). Their purpose was to evaluate the presence of increased Colour Doppler activity in the population presenting to a sport medicine clinic. It was assumed that by recruiting from a sport medicine clinic, these patients would be a closer representation of Achilles tendinopathy patients in comparison to sampling from other establishments. Unlike the control subjects, these individuals were not required to complete the eccentric training protocol. To be included, they had to be adults, 18 years of age or older, with no history of lower extremity injuries.

The adults with painful chronic Achilles tendinopathy and the control subjects were instructed on a home based heavy

load eccentric training program based on the Alfredson protocol of straight leg followed by bent knee heel drops and raises (three sets of fifteen repetitions with a straight knee and three sets of fifteen repetitions with a slightly bent knee) [12]. During the training regimen, patient-specific recreational activities were allowed if they could be performed with only mild or no discomfort but no pain.

Adults who had bilateral Achilles tendinopathy were instructed on the eccentric program for both legs; however, it was decided *a priori* that the worst tendon at baseline (the tendon with the lowest VISA-A score) would be used in the analysis.

Outcome Measures and Analysis

During their baseline visit, each patient completed a baseline clinical questionnaires (Victorian Institute of Sport Assessment – Achilles (VISA-A), visual analogue scales (VAS), Tegner Activity Scale) and received personal instructions on how to complete the program. Also, all participants were required to undergo a Doppler ultrasound (15-8 MHz linear array transducer) examination at baseline. Clinical information related to Achilles tendinopathy was recorded by a sports medicine physician.

During the 12 week eccentric training protocol, the cohort of adults with Achilles tendinopathy and the cohort of control subjects (graduate students) were required to attend a follow-up visit at six weeks. At this time, everyone was required to complete a clinical questionnaires and a follow-up data questionnaire that included a patient subjective question on satisfaction with treatment. Compliance with the eccentric training protocol was encouraged and monitored with log books and reviewed at the six week follow-up visit along with participant

TABLE 2. Baseline characteristics of adults diagnosed with Achilles tendinopathy, patients without Achilles tendinopathy who did not undergo training and control subjects

		Patients diagnosed with Achilles tendinopathy (n = 20)	Patients not diagnosed with Achilles tendinopathy (n = 7)	Control subjects (n = 21)
Gender	Male	9/20	2/7	8/21
	Female	11/20	5/7	13/21
BMI		27.2 (7.48) [19.0-51.5]	25.9 (5.83) [20.6-37.3]	23.4 (4.38) [15-34.9]
Age (years)		49.2 (9.07) [33-65]	45.9 (10.51) [30-59]	27.9 (2.93) [25-37]
Bilateral		5/20		
Location	Midportion	16/20		
	Enthesitis	4/20		
Previous Treatments		20/20		
Baseline VISA-A score		45.4 (18.1) [9-83]	93.4 (4.72) [90-100]	95 (6.37) [77-100]
Baseline VAS (tendon loading)		58.95 (22.37) [15-87]	0 (0) [0]	2.05 (5.66) [0-23]
Baseline VAS (ADL)		35.55 (24.39) [0-78]	0 (0) [0]	0 (0) (0)
Baseline Tegner score		3.5 (1.61) [2-7]	4.14 (2.03) [1-7]	5.01 (1.34) [3-7]

Note: Results expressed as mean (SD) [range] unless specified. BMI = body mass index, VISA-A = Victorian Institute of Sports Assessment – Achilles, VAS = Visual Analogue Scale, ADL = activities of daily living. Adults without Achilles tendinopathy did not undergo training. Control subjects did not exhibit Achilles tendinopathy but did undergo training.

log form for medications. This was seen as a reasonable time period when a follow-up appointment in the clinical setting would occur and served not only to reinforce correct technique and progression of the program, but also to reassure patients with regards to any muscle soreness from the exercises. At 12 weeks, patients and control subjects underwent an ultrasound examination for increased Colour Doppler activity and degenerative tendon characteristics and completed all of the outcome scores and questionnaires. The radiologist was blinded to the cohort allocation (whether it was a patient or control subject).

The primary outcome was subjective patient satisfaction which was compared to the average satisfaction present in the literature of 60 to 90% using a binomial probability test. It was subjectively evaluated using the following question: Are you satisfied with the current treatment you are receiving or do you require further treatment to alleviate the pain and other symptoms resulting from your Achilles tendon pain ('satisfied' versus 'further treatment required')? Two other questions were also asked for descriptive purposes: 1) Did the current treatment you are receiving improve your ability to perform strenuous activities (e.g., running); and, 2) Did the current treatment you are receiving improve your ability to perform activities of daily living (e.g., walking). In this case, the hypothesis was $H_0: \pi_1 = \pi_2$. As the data followed a binomial distribution, a binomial probability test was performed.

Ancillary outcomes included a 100 mm VAS pain ratings for two different situations (overall pain in Achilles during tendon loading and overall pain in Achilles during regular ac-

tivities), Tegner Activity Scale [20] and VISA-A [21]. Outcome measurements were assessed at baseline and at six and 12 weeks for the adults with painful chronic Achilles tendinopathy. Semi-quantitative ultrasound grading systems of the tendon and vascularisation used modified procedures previously employed by Archambault and by Boesen [22, 23]. An (a) and (b) designation were added to the Archambault system to describe calcification, and a Part 2 was added to the Boesen system to quantify number of neovessels. Patients were considered compliant if their log book showed that they completed at least 80% of the protocol.

Statistical analysis was completed using Stata 10. Results are presented as mean, range values, 95% confidence intervals and *p*-values. The binomial probability test was used to assess satisfaction with treatment within the patient cohort.

One patient withdrew from the study after completion of the 12 week eccentric training protocol. They were included in the unsatisfied group of patients as per their final assessment.

Results

Forty-eight adults (20 participants diagnosed with Achilles tendinopathy, seven adults without Achilles tendinopathy and 21 control subjects without Achilles tendinopathy) were included in the study (Table 2). All participants with Achilles tendinopathy had at least three months of pain and were not able to participate in their regular tendon loading activities because of pain.

FIGURE 1. Scores during the 12week treatment schedule for all patients with chronic painful Achilles tendinopathy. The graph illustrates the score for each patient who was either satisfied (dot) or not satisfied (circle) after 12 weeks: (a) VISA-A, (b) VAS scores (overall pain in Achilles tendon during tendon loading activity), (c) VAS scores (overall pain in Achilles tendon during regular activities of daily living) and (d) Tegner.

Participants with chronic painful Achilles tendinopathy were involved in a variety of activities including walking, running, basketball, soccer, skiing and other sports and had tried a number of treatments including rest (20), NSAIDS (15), physiotherapy (18), acupuncture (2), ultrasound (2), orthotics (2) and night splints (1). Seventeen of twenty participants completed at least 80% of the program and were considered compliant. Although the three participants who were considered non-compliant completed over 50% of the program, they

were unable to perform the exercises twice per day due to the extreme pain that resulted when performing the exercises.

Satisfaction of those participants with the various treatments for their chronic painful Achilles tendinopathy was significantly lower (two patients reported that they were satisfied with the treatment while the remaining 18 reported that they were unsatisfied) when compared with the literature ($p=0.0174$). An improved VISA-A score was recorded in both satisfied and not satisfied patients (Figure 1), as well as an improved VAS and Tegner score. There was no statistically signifi-

TABLE 3. Ultrasound and outcome results for patients diagnosed with Achilles tendinopathy, patients without Achilles tendinopathy and control subjects

			Patients diagnosed with Achilles tendinopathy	Patients not diagnosed with Achilles tendinopathy	Control subjects
Increased Colour Doppler activity (number of neovessels)	Baseline		3.77 (2.60) [1-10]	0 (0) [0]	0 (0) [0]
Increased Colour Doppler activity (number of neovessels)	Visit 2		4.28 (2.67) [0-10]		0.095 (0.301) [0-1]
Appearance of tendon	Baseline	1	2/20	7/7	21/21
		2a	15/20	0	0
		2b	1/20	0	0
		3a	2/20	0	0
		3b	0	0	0
Appearance of Tendon	Visit 2	1	3/20		21/21
		2a	14/20		0
		2b	0		0
		3a	3/20		0
		3b	0		0
VISA-A Score	Baseline		58.8 (19.03) [26-90]	93.4 (4.72) [90-100]	95 (6.37) [77-100]
	Visit 2		63.95 (19.67) [32-95]		94.1 (8.37) [70-100]
VAS Score (tendon loading)	Baseline		43 (23.22) [0-71]	0 (0) (0)	2.05 (5.66) [0-23]
	Visit 2		32.79 (23.23) [0-70]		4.52 (12.65) [0-52]
VAS Score (ADL)	Baseline		29.6 (21.09) [0-59]	0 (0) (0)	0 (0) [0]
	Visit 2		25.37 (20.24) [0-58]		0.62 (1.96) [0-7]
Tegner Score	Baseline		3.6 (1.57) [1-7]	4.14 (2.03) (1-7)	5.01 (1.34) [3-7]
	Visit 2		4.11 (2.05) [1-9]		4.95 (1.53) [2-7]

Note: Results expressed as mean (SD) [range]. VISA-A = Victorian Institute of Sports Assessment – Achilles, VAS = Visual Analogue Scale, ADL = activities of daily living.

cant difference in the change of VISA-A, VAS and Tegner scores from baseline to 12 weeks in the satisfied and not satisfied patients (Table 5).

With the exception of one control subject, all of the adults without the condition had no increased Colour Doppler activity visible using ultrasound, and the remainder of the control subjects had no increased colour Doppler activity during their first ultrasound. One increased Colour Doppler activity was visible during the control subject's second ultrasound; however, the tendon appearance was considered grade 1 or a normal-appearing tendon. In comparison 8/20 patients with chronic painful Achilles tendinopathy had increased Colour Doppler activity visible during their first ultrasound evaluation, and 19/20 had increased Colour Doppler activity visible during their second ultrasound (one being satisfied with treatment).

Discussion

Overall, patients' symptoms in this study improved over time, but a home-based heavy load eccentric training program did not satisfy patient expectations of improvement following treatment even in patients with good compliance over the 12-week period. Unlike other studies, the patient population varied with regards to their activity level (most of the literature is based on runners and often semi-competitive to competitive runners) [10,12,13]. Results are consistent with recent reviews questioning the effectiveness of eccentric training for Achilles tendinopathy [16,24,25].

Achilles tendinopathy has been attributed to a number of possible intrinsic and extrinsic factors including age, weight, height and BMI [17,24,26-30]. A study by Longo *et al.* (2009) suggested that there may be no influence of age, weight and height on the occurrence of Achilles tendinopathy [31]. Although the population in the present study is different, age and

TABLE 4. Characteristics of 25 tendons in 20 patients with chronic painful Achilles tendinopathy: comparison between subjects who were satisfied and not satisfied following treatment

Variable	Satisfied (n=2)	Not Satisfied (n=18)	p-value
Female	1/2	10/18	0.9414
Age	44 (1.41) [43-45]	48.88 (9.62) [33-65]	0.4942
Height (m)	1.68 (0.11) [1.6-1.75]	1.73 (0.11) [1.57-1.98]	0.5238
Weight (kg)	71.44 (11.23) [63.5-79.38]	82.36 (25.82) [48.53-138.35]	0.5695
BMI	25.32 [0.74, 24.8-25.8]	27.46 (7.93) [18.86-51.49]	0.7151
Insertional Tendinopathy	0/2	4/18	0.4682
Bilateral	1/2	4/18	0.4496
Increased colour Doppler activity at 12 weeks	1/2	18/18	0.0012
Baseline VISA-A Score	65 (6.36) [61-70]	43.17 (17.60) [9-83]	0.0980
Baseline VAS (tendon loading)	50.5 (28.99) [30-71]	59.89 (22.36) [15-87]	0.5872
Baseline VAS (ADL)	15 (21.21) [0-30]	37.83 (24.15) [5-78]	0.2180
Baseline Tegner Score	4 (2.83) [2-6]	3.44 (1.52) [2-7]	0.6550
12 week VISA-A Score	94 (0) [94]	60.41 (17.58) [32-95]	0.0174
12 week VAS (tendon loading)	0 (0) [0]	36.65 (21.37) [0-70]	0.0302
12 week VAS (ADL)	0 (0) [0]	28.35 (19.26) [0-58]	0.0583
12 week Tegner Score	6.5 (0.71) [6-7]	3.82 (1.98) [1-9]	0.0802
Compliance with program	2/2	15/18	0.9414

Note: Results expressed as mean (SD) [range]. VISA-A = Victorian Institute of Sports Assessment – Achilles, VAS = Visual Analogue Scale, ADL = activities of daily living.

BMI were not similar between the adults with chronic painful Achilles tendinopathy and the adults without the condition in this study. Still, the causal pathway of Achilles tendinopathy remains largely unclear due to a lack of sufficient research. Decreasing vascularity, blood flow, and tensile strength of the tendon could be related to age, making it more susceptible to injury. An enhanced understanding of factors such as age and BMI, and how these relate to Achilles tendinopathy, would allow for new advances in prevention.

The varying methods of describing and assessing the degree of increased Colour Doppler activity contributes to inconsistencies in the literature; therefore, various scoring methods have been developed [32]. The complexity of some ultrasound imaging forms, however, can cause the methods to become unusable. The radiologists involved in this study found the surface area measurement and region of interest section of the form to be cumbersome and not a realistic task to be performed in a true clinical setting. As a result, this part of the form was removed and left blank for all patients. This change increased the efficiency of the procedure, thereby making it more applicable

to an actual clinical setting; however, it reduced the ability to use increased Colour Doppler activity to assess the severity of the disease.

Although the sample size is small, increased Colour Doppler activity could be detected with Doppler ultrasound in all of the symptomatic and unsatisfied patients at the end of the protocol and in only one of the participants without the disease suggesting that increased Colour Doppler activity has a relationship with chronic painful Achilles tendinopathy. Clinically, the presence of increased Colour Doppler activity might be used to confirm the diagnosis of Achilles tendinopathy, to increase the accuracy of the prognosis, or to direct treatment; however, this hypothesis requires further exploration.

Previous research suggested that eccentric exercises attenuate the increased Colour Doppler activity visible by ultrasound, which, in turn, reduces the pain associated with Achilles tendinopathy [33,34]. Yet this causation model is arbitrary, for no literature circumvents the potential for increased Colour Doppler activity to form as a result of eccentric exercises. After 12 weeks of performing the heavy load eccentric training program,

TABLE 5. Means, 95% confidence intervals and *p*-values of the change in outcome measure score from baseline to 12 weeks in the satisfied and not satisfied patients with chronic painful Achilles tendinopathy

Variable	Satisfied (n=2)	Not Satisfied (n=18)	<i>p</i> -value
VISA-A Score	28.5 (-28.68, 85.68)	16.78 (6.31, 27.25)	0.4533
VAS (tendon loading)	-50.5 (-310.98, 209.98)	-22.22 (-37.14, -7.30)	0.2213
VAS (ADL)	-15 (-205.59, 175.59)	-8.11 (-19.24, 3.02)	0.6837
Tegner Score	2.5 (-29.27, 34.27)	0.33 (-0.62, 1.28)	0.1702

Note: VISA-A = Victorian Institute of Sports Assessment – Achilles, VAS = Visual Analogue Scale, ADL = activities of daily living.

only one control subject showed signs of increased Colour Doppler activity with an otherwise asymptomatic and normal-appearing tendon. This suggests that increased Colour Doppler activity likely does *not* form as a result of eccentric exercises in healthy tendons; however, the magnitude (mean) of increased Colour Doppler activity increased in the symptomatic cohort following eccentric training. This increase is opposite to what was expected based on the literature. The quantification method of increased colour Doppler activity is a possible explanation of this result. Another possible explanation is that the increased colour Doppler activity is part of the healing process rather than the disease process.

The study was limited by a number of factors: it was not randomized or blinded and the sample size was small. The study was also limited by the use of the subjective outcomes measures VISA-A, VAS and Tegner scales. The VAS scales were included to compare with most of the other eccentric exercise studies that used pain measured by VAS as an outcome measure. Nonetheless, pain intensity alone as a primary outcome measure has been questioned, with one review stating that it would be more clinically relevant to use an outcome measure that takes into consideration the function of the Achilles tendon, patient's activity level, and patient's participation level [16]. This was taken into consideration and accounts for the use of the VISA-A. The VISA-A is limited by its subjective nature, which relies on the patient comprehending and completing the form accurately and truthfully; it also assumes that a patient's perception of pain and function can be standardized on a linear and numerical scale. One patient who was unsatisfied at 12 weeks recorded ninety-five points on the VISA-A, zero on the VAS (pain during regular daily activities) and nine on the Tegner, which is inconsistent with the recordings of the other unsatisfied patients.

The log books are also a limitation, for one cannot chart if patients completed the logbooks truthfully, accurately and

completely. More patient contact with the investigator is one method that could have improved the legitimacy of the logbooks; however, this would have altered the study from one of effectiveness to efficacy, and, therefore, patient contact was limited to what would be more realistic in a regular patient-physician care setting.

Even with these limitations, this study adds to the growing evidence questioning the effectiveness of eccentric exercises for Achilles tendinopathy. Most of the reviews on the effectiveness of Achilles tendinopathy are consistent in their recommendations for future research: standardized Achilles specific outcome measures, long-term follow-up, adequate power, and appropriate randomization and blinding procedures [16,24,25]. The reviews also allude to a lack of efficacy stating that the results of many studies should be viewed with caution due to low methodological quality [16,24,25]. Furthermore, they observe that the treatment regime was largely based on clinical experience rather than being derived from empirical data putting into question the optimal dosage (loading parameters, progression and frequency) of the exercises [25].

While the recommendations by reviews regarding eccentrics in the literature are echoed by the results of this study, the apparent simplicity of the treatment and its conservative (non-surgical) nature may continue to make it a treatment option for many physicians. A recent case series found that a majority of patients showed improved symptoms with up to five years of treatment – too long a time frame for many patients [35]. Eccentric exercises may provide adequate relief of symptoms if there is constant supervision by a healthcare professional; however, it is not effective for patients to use as a treatment otherwise. A decision/economic analysis study should be performed to study the appropriateness of eccentric exercises as a treatment for Achilles tendinopathy, taking into consideration the relative benefits to the patient and the health care system. Including as many of the other treatment options currently em-

ployed or suggested for clinical practice in a decision/economic analysis would add more to the body of evidence surrounding eccentric exercises for Achilles tendinopathy than another soundly performed RCT.

Acknowledgments

The authors would like to thank the Department of Radiology, Foothills Medical Centre, University of Calgary for its expertise and assistance with ultrasound assessments.

References

- Jarvinen M. Epidemiology of tendon injuries in sports. *Clinics in Sports Medicine*. 1992;11(3):493-504.
- Jarvinen TA, Kannus P, Paavola M, Jarvinen TL, Jozsa L, Jarvinen M. Achilles tendon injuries. *Current Opinion in Rheumatology*. 2001;13(2):150-5.
- Kannus P, Natri A. Etiology and pathophysiology of tendon ruptures in sports. *Scandinavian Journal of Medicine & Science in Sports*. 1997;7(2):107-12.
- Mazzone MF, McCue T. Common conditions of the achilles tendon. *American Family Physician*. 2002;65(9):1805-10.
- Leppilahti J, Puranen J, Orava S. Incidence of Achilles tendon rupture. *Acta Orthop Scand*. 1996;67(3):277-9.
- McLauchlan GJ, Handoll HH. Interventions for treating acute and chronic Achilles tendinitis. *Cochrane Database of Systematic Reviews*. 2004;2.
- Kvist H, Kvist M. The operative treatment of chronic calcaneal paratenonitis. *Journal of Bone and Joint Surgery (British Volume)*. 1980;62(3):353-7.
- Leppilahti J, Orava S, Karpakka J, Takala T. Overuse injuries of the Achilles tendon. *Annales Chirurgiae et Gynaecologiae*. 1991;80(2):202-7.
- Rompe JD, Nafe B, Furia JP, Maffulli N. Eccentric loading, shock-wave treatment, or a wait-and-see policy for tendinopathy of the main body of tendo Achillis: a randomized controlled trial. *Am J Sports Med*. 2007;35(3):374-83. Epub 2007/01/25.
- Mafi N, Lorentzon 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 Surgery, Sports Traumatology, Arthroscopy*. 2001;9(1):42-7.
- Silbernagel KG, Thomee R, Thomee P, Karlsson J. Eccentric overload training for patients with chronic Achilles tendon pain--a randomised controlled study with reliability testing of the evaluation methods. *Scandinavian Journal of Medicine & Science in Sports*. 2001;11(4):197-206.
- Alfredson H, Pietila T, Jonsson P, Lorentzon R. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. *American Journal of Sports Medicine*. 1998;26(3):360-6.
- Fahlstrom M, Jonsson P, Lorentzon R, Alfredson H. Chronic Achilles tendon pain treated with eccentric calf-muscle training. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2003;11(5):327-33.
- Roos EM, Engstrom M, Lagerquist A, Soderberg B. Clinical improvement after 6 weeks of eccentric exercise in patients with mid-portion Achilles tendinopathy -- a randomized trial with 1-year follow-up. *Scandinavian Journal of Medicine & Science in Sports*. 2004;14(5):286-95.
- Alfredson H, Cook J. A treatment algorithm for managing Achilles tendinopathy: new treatment options. *Br J Sports Med*. 2007;41(4):211-6. Epub 2007/02/22.
- Kingma JJ, de Knikker R, Wittink HM, Takken T. Eccentric overload training in patients with chronic Achilles tendinopathy: a systematic review. *Br J Sports Med*. 2007;41(6):e3. Epub 2006/10/13.
- Rees JD, Wilson AM, Wolman RL. Current concepts in the management of tendon disorders. *Rheumatology (Oxford)*. 2006;45(5):508-21.
- Jonsson P, Alfredson H, Sunding K, Fahlstrom M, Cook J. New regimen for eccentric calf-muscle training in patients with chronic insertional Achilles tendinopathy: results of a pilot study. *British Journal of Sports Medicine*. 2008;42(9):746-9. Epub 2008/01/11.
- Sayana MK, Maffulli N. Eccentric calf muscle training in non-athletic patients with Achilles tendinopathy. *Journal of Science and Medicine in Sport*. 2007;10(1):52-8. Epub 2006/07/11.
- Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. *Clin Orthop Relat Res*. 1985(198):43-9.
- Robinson JM, Cook JL, Purdam C, Visentini PJ, Ross J, Maffulli N, et al. The VISA-A questionnaire: a valid and reliable index of the clinical severity of Achilles tendinopathy. *British Journal of Sports Medicine*. 2001;35(5):335-41.
- Archambault JM, Wiley JP, Bray RC, Verhoef M, Wiseman DA, Elliott PD. Can sonography predict the outcome in patients with achillodynia? *Journal of Clinical Ultrasound*. 1998;26(7):335-9.
- Boesen MI, Koenig MJ, Torp-Pedersen S, Bliddal H, Langberg H. Tendinopathy and Doppler activity: the vascular response of the Achilles tendon to exercise. *Scand J Med Sci Sports*. 2006;16(6):463-9. Epub 2006/11/24.
- Rees J, Maffulli N, Cook J. Management of Tendinopathy. *American Journal of Sports Medicine*. 2009. Epub 2009/02/04.
- Woodley BL, Newsham-West RJ, Baxter GD. Chronic tendinopathy: effectiveness of eccentric exercise. *British Journal of Sports Medicine*. 2007;41(4):188-98; discussion 99. Epub 2006/10/26.
- Hargrove R. Achilles Tendon Pathology. [Public]: eMedicine; 2006 [updated August 10, 2005; cited 2006 June 3, 2006]; Available from: <http://www.emedicine.com/orthoped/topic459.htm>.

27. Hennessy MS, Molloy AP, Sturdee SW. Noninsertional Achilles tendinopathy. *Foot Ankle Clinics*. 2007;12(4):617-41, vi-vii. Epub 2007/11/13.
28. Kader D, Saxena A, Movin T, Maffulli N. Achilles tendinopathy: some aspects of basic science and clinical management. *British Journal of Sports Medicine*. 2002;36(4):239-49. Epub 2002/07/30.
29. Maffulli N, Kader D. Tendinopathy of tendo achillis. *Journal of Bone and Joint Surgery (British Volume)*. 2002;84(1):1-8.
30. Maffulli N, Sharma P, Luscombe KL. Achilles tendinopathy: aetiology and management. *Journal of the Royal Society of Medicine*. 2004;97(10):472-6.
31. Longo UG, Rittweger J, Garau G, Radonic B, Gutwasser C, Gilliver SF, et al. No influence of age, gender, weight, height, and impact profile in achilles tendinopathy in masters track and field athletes. *American Journal of Sports Medicine*. 2009;37(7):1400-5. Epub 2009/03/31.
32. Sengkerij PM, de Vos RJ, Weir A, van Weelde BJ, Tol JL. Interobserver reliability of neovascularization score using power Doppler ultrasonography in midportion achilles tendinopathy. *American Journal of Sports Medicine*. 2009;37(8):1627-31. Epub 2009/04/11.
33. Ohberg L, Lorentzon R, Alfredson H. Eccentric training in patients with chronic Achilles tendinosis: normalised tendon structure and decreased thickness at follow up. *British Journal of Sports Medicine*. 2004;38(1):8-11.
34. Ohberg L, Alfredson H. Effects on neovascularisation behind the good results with eccentric training in chronic mid-portion Achilles tendinosis? *Knee Surgery, Sports Traumatology, Arthroscopy*. 2004;12(5):465-70.
35. Silbernagel KG, Brorsson A, Lundberg M. The majority of patients with Achilles tendinopathy recover fully when treated with exercise alone: a 5-year follow-up. *The American journal of sports medicine*. 2011;39(3):607-13. Epub 2010/11/19.