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Conservative management of Achilles Tendinopathy: a case report

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Objective: *To chronicle the conservative treatment and management of a 77-year old female patient presenting with chronic pain of 8 months duration in the midportion of the achilles tendon diagnosed as achilles tendinopathy.*

Clinical features*: The main clinical feature was pain in the midportion of the achilles tendon, 2 to 6 cm proximal to the calcaneal insertion. Symptom onset was gradual and unrelated to any acute trauma or overt injury mechanism.*

Intervention and outcome*: The conservative treatment approach consisted of medical acupuncture with electrical stimulation, Graston Technique®, eccentric calf training, and rehabilitative exercise prescription. Outcome measures included verbal pain rating scale, lower extremity functional scale (LEFS), and a return to activities of daily living (ADLs). The patient attained long-term resolution of her complaint and at 12 month follow-up reported no recurrence of symptoms.*

Conclusion: *A combination of conservative rehabilitation strategies may be used by chiropractors to treat midportion achilles tendinopathy and allow an individual to return to pain free ADLs in a timely manner.*
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KEY WORDS: achilles, tendinosis, tendinopathy, Graston Technique®, eccentric training

Objectif : *Documenter le traitement conservateur et la gestion d'une patiente de 77 ans qui présente de la douleur chronique depuis 8 mois dans la partie du milieu du tendon d'Achille, diagnostiquée comme une tendinopathie du tendon d'Achille.*

Caractéristiques cliniques : *La caractéristique clinique principale est la douleur ressentie dans la partie du milieu du tendon d'Achille, à 2 à 6 cm proximal à l'insertion calcanéenne. L'apparition des symptômes s'est produite graduellement et n'est pas associée à un trauma aigu ou à un mécanisme de blessure évident.*

Intervention et résultat : *L'approche adoptée pour le traitement conservateur comporte l'acupuncture médicale avec stimulation électrique, la technique Graston[MD], l'entraînement excentrique du mollet et la prescription d'exercices de réadaptation. Les résultats ont notamment été mesurés au moyen d'une échelle verbale de notation de la douleur, d'une échelle fonctionnelle des membres inférieurs (ÉFMI) et du retour aux activités de la vie quotidienne (AVQ). Une résolution à long terme a été apportée à la plainte de la cliente et, au rendez-vous de suivi, douze mois plus tard, aucune récurrence des symptômes n'a été rapportée.*

Conclusion : *Les chiropraticiens peuvent employer une combinaison de stratégies de réadaptation conservatrices afin de traiter une tendinopathie de la partie du milieu du tendon d'Achille et de permettre à une personne de retourner à ses AVQ sans douleur et en temps opportun.*
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MOTS CLÉS : Achille, tendinose, tendinopathie, technique Graston[MD], entraînement excentrique

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Introduction:

The term "*tendonitis"* has traditionally been used to denote overuse injury to the tendon that is chronic in nature. The suffix "itis" implies the presence of an inflammatory condition. However, studies have identified little or no inflammation within tendons exposed to overuse.[1-3] *Tendinopathy* is now commonly used to describe overuse injuries in the absence of histological confirmation and includes a range of diagnoses involving injury to the tendon (e.g., tendonitis, peritendinitis, tendinosis).[4,5]

The pathogenesis of Achilles tendinopathy (ATY) begins when the mode, intensity, or duration of a physical activity changes and places an abnormal biomechanical demand on the achilles tendon.[6,7] This is followed by an inadequate recovery period and is believed to lead to breakdown at the cellular level.[8] What results is an incomplete healing response that can be attributed to ongoing mechanical forces on the tendon, poor blood supply, or a combination of both.[9,10] The tendon undergoes microscopic changes, including fibrin deposition, reduction in neutrophils and macrophages, neovascularization, and disorganization of collagen fibers.[11,12] The neovascularization within the degenerated achilles tendon is accompanied by an in-growth of nerve fascicles.[13-15] These nerve fibers have both sensory and sympathetic components that may be responsible, in part, for the pain that is associated with ATY.[8,14,15]

The mean age of those affected by achilles tendon disorders has been reported to range between 30 and 50 years[16-18], with data suggesting males are affected to a greater extent than females[16]. ATY is generally more common among individuals who increase their usual activity levels or participate in sports.[19,20] However, less active individuals may also be affected as a minority of cases have been reported in sedentary groups.[21,22] In one series of 58 patients, nearly one-third did not participate in vigorous physical activity.[20] Onset within the sedentary population may be attributed to physical deconditioning, intrinsic risk factors, or co-morbidities associated with ATY.[6,22]

The long-term prognosis for patients with acute to sub-chronic ATY has been reported as favourable with nonoperative treatment.[23,24] Significant decreases in pain and improvement in function have been reported in cases treated with exercise interventions.[25-27] Long-term follow-up ranging between 2 and 8 years suggests that between 71% to 100% of patients with ATY are able to return to their prior level of activity with minimal or no complaints.[24,28,29] It has also been reported that results of both conservative[30] and operative treatments[31] are less favourable in nonathletic populations and in those with insertional tendinopathy versus midportion tendinopathy[32].

Chronic tendon pathology is a soft tissue condition commonly seen in chiropractic practice[33], and chiropractors can provide a number of conservative interventions used to treat tendinopathy[34]. This case study was conducted to chronicle the conservative treatment and management of a 77-year old female patient presenting with chronic pain in the midportion of the achilles tendon, diagnosed as ATY.

Case report:

A 77-year old female presented with chronic pain of 8 months duration in the midportion of the right achilles tendon. The complaint was one of gradual onset and not related to any acute trauma or overt injury mechanism. The patient was a retiree who stated that she maintained a busy schedule looking after her country home. This included outdoor maintenance and management of her large garden. She reported that her pain had progressed to the point of limiting activities of daily living (ADLs) such as walking greater than 15 minutes and descending/ascending stairs. The patient also reported now occasionally feeling pain at rest. Decreasing her activity levels and cryotherapy provided short term relief. She presented to her family physician's office 5 months prior and a referral was made to another health professional for evaluation of her achilles pain. The patient reported that she was examined and fitted for a pair of custom orthotics. Despite several modifications and three months of use, the custom orthotics did not provide any significant pain relief or functional improvements in her ADLs.

The patient rated her current pain level on the Verbal Pain Rating Scale (VPRS) where 0 is "no pain" and 10 is the "worst pain that she had ever experienced". She reported her pain as ranging from 2-3/10 occasionally at rest, and 6-7/10 with activity (i.e. walking greater than 15 minutes and ascending/descending stairs). Her Lower Extremity Functional Scale (LEFS) score was 48. The LEFS is a subjective outcome measure, comprised of 20 items, that asks individuals to rate their difficulty in performing a variety of everyday activities (where 0 is "unable to perform" and 4 is "no difficulty"). The final LEFS

Figure 1 *Right sided Achilles Tendinopathy resulting in noticeable swelling*

Figure 2 A-C *The eccentric training protocol for Achilles Tendinopathy. Illustrations demonstrate the gastrocnemius portion of the program.* ***(A)*** *The patient starts in a single-leg standing position with the knee straight, weight on the forefoot and the ankle in full plantar flexion.* ***(B)*** *The achilles is then eccentrically loaded by slowly lowering the heel into a dorsiflexed position.* ***(C)*** *The patient returns to the starting position using the contralateral unaffected leg to avoid concentric loading of the symptomatic achilles tendon. This protocol was also repeated with the knee flexed at 45 degrees to engage the soleus.*

score can vary from 0 (low) to 80 (normal function)[35]. The patient's past medical history was unremarkable for any right lower extremity injury or condition. A full systems review was normal with the exception of a long-standing history of bronchioectasis and related use of a corticosteroid inhaler as required.

Upon examination, inspection of the right lower extremity revealed swelling around the right achilles tendon (Figure 1). Hallux valgus was visible bilaterally as was left-sided sub-talar varus. One-legged squat testing revealed bilateral foot over pronation, along with internal femoral and tibial rotation. The patient was able to rise to her toes bilaterally, albeit with some discomfort noted on the right. With repeated heel raises, she reported increasing discomfort in the right achilles tendon and had to stop after six repetitions. Diminished balance was observed on the right with inability to maintain a one-legged stance. Range of motion (ROM) for the right knee and right hip joint was within physiological limits. Active and passive ROM at the right ankle was diminished by 25% in dorsiflexion. Palpation revealed tenderness and soft tissue thickening 3 cm from the heel along the course of the achilles tendon and into the gastrocnemius-soleus complex. Palpation also revealed tenderness in the following soft tissues of the right lower extremity: flexor hallucis longus, flexor digitorum longus, tibialis posterior, distal vastus medialis oblique, and gluteus medius and minimus. Evaluation for achilles tendon rupture was done with the Thompson test[19] and was negative in this patient. Motor, reflex, and sensory testing for the lower extremities was within normal limits bilaterally. Supine straight leg raising was unremarkable for nerve root tension signs bilaterally.

The patient was diagnosed with ATY. Treatment was initiated and consisted of medical acupuncture (points consisting of physiological tender regions within the painful achilles tendon and gastrocnemius-soleus complex) with electrical stimulation (IC-1107+ at 2 Hz frequency). Graston Technique® (GT) was administered by a certified provider using GT protocols to all the affected soft tissues following each acupuncture treatment.

The patient was initially prescribed exercises consisting of static stretching for the gastrocnemius and soleus muscles. In addition, unilateral eccentric heel drops with no concentric component were prescribed for each respective muscle group (Figure 2 A-C). The patient was

Table 1. *Overview of treatment sessions, in office treatment, and rehabilitative exercise intervention(s)*

WEEK(S) SESSIONS	IN OFFICE TREATMENT	REHABILITATIVE EXERCISE INTERVENTION(S)
WEEK-1 • 2 sessions	• Medical acupuncture (points consisting of physiological tender regions within the painful achilles tendon and gastrocnemius-soleus complex) with electrical stimulation (IC-1107+ at 2 Hz frequency) • Augmented soft tissue mobilization (ASTM) Graston Technique® (GT) applied to all the tender/dysfunctional soft tissues as per physical examination findings	• **Stretching:** Gastrocnemius and Soleus, 15-20 second holds, 8-10 repetitions (reps) for each respective stretch • **Eccentric heel drops:** 3 sets of 10 reps • For gastrocnemius: knee fully extended (Figure 2 A-C) • For Soleus: knee flexed 45 degrees *Exercise performed 2 times/week in office, 3 times/week at home
WEEK-2 • 2 sessions	• Medical acupuncture and ASTM GT, same as above (SAA)	• **Stretching** and **Eccentric heel drops:** SAA *Exercise performed 2 times/week in office, 3 times/week at home
WEEK 3 • 2 sessions WEEK 4 • 2 sessions	• SAA • SAA	• **Stretching:** Gastrocnemius and Soleus (SAA): Addition of hamstring and quadricep muscle groups • **Eccentric heel drops:** 3 sets of 15 reps • **Proprioception** – 1-legged stance • Introduction of **lumbopelvic conditioning** and **lower extremity strengthening:** Bridging; side-lying hip abduction; VMO training with quad sets and supine straight leg raise; theraband inversion, eversion, dorsiflexion strengthening for right foot; Exercise prescription = 2-3 sets of 8-10 reps *Exercise performed 2 times/week in office, 3 times/week at home
WEEK 5, 6, 7, 8 • 1 session each week	• SAA	• **Stretching** and **Eccentric heel drops:** SAA • **Proprioception:** Rocker board training in office; Home proprioceptive challenge increased by performing 1-legged stance and introducing arm movements • **Lumbopelvic conditioning** and **lower extremity strengthening:** VMO training advanced to shallow wall squats; addition of theraband hip abduction and adduction in the standing position; Exercise prescription = 2-3 sets of 8-10 reps *Exercise performed 1 time/week in office, 4 times/week at home
WEEK 9 • Discharge	• N/A	• Discharged, encouraged to continue with home program

instructed to assist with the unaffected contralateral lower extremity during the concentric (plantar flexion) movement phase, helping return the affected ankle to the starting position. Exercises were added as the treatment plan progressed. A summary of the full treatment protocol and prescribed exercises is included in Table 1.

The patient was seen twice a week for 4 weeks and then once per week for 4 weeks for a total of 12 treatment visits. Gradual improvement was reported during the entire course of treatment. At week 9, the patient reported a VPRS score of 0/10. Her LEFS score improved from 48 to 80. A change of 9 points or more is considered to represent a clinically meaningful functional change.[35] Physical examination at this time revealed only mild tenderness in the midportion of the achilles tendon and into the gastrocnemius-soleus complex. ROM, functional, and palpatory testing was otherwise within normal limits. The patient was encouraged to continue with her exercise program and was subsequently discharged from active care. At 12 month follow-up conducted via telephone, the patient reported no recurrence of symptoms.

Discussion:

The achilles tendon is the largest[36] and strongest[37] tendon in the body, and serves as the conjoined tendon for the gastrocnemius and soleus muscles[38]. The achilles tendon does not have a true synovial sheath but instead has a paratenon.[19,39] The paratenon is a connective tissue sheath that surrounds the entire tendon and is able to stretch 2 to 3 cm with movement, which allows for maximal gliding action.[19] Initial inflammation of this layer with subsequent thickening and adhesion formation can result in diminished tendon flexibility and predispose the achilles to further injury.[40] The area of the tendon with the poorest blood supply is approximately 2 to 6 cm above the insertion into the calcaneus.[8,20,41] Blood supply to this region further diminishes with increasing age.[19] This hypovascular region is most commonly implicated in achilles tendinopathy[19,20,41,42] and rupture[41].

The etiology of ATY appears to be multi-factorial, with both extrinsic and intrinsic risk factors likely contributing.[6,8,38,43] Extrinsic risk factors include training errors, increased training volume or physical activity, environmental variables, and use of faulty equipment or improper footwear.[20,38] Intrinsic risk factors to consider include abnormal ankle dorsiflexion range of motion, abnormal subtalar joint range of motion, decreased ankle plantar flexion strength, increased foot pronation, increasing age, and genetic factors.[6,10,22,38,44] Co-morbidities of obesity, hypertension, hypercholesterimia, and diabetes[38] can also contribute, and the presence of systemic inflammatory disease[45] and the use of antibiotics in the fluoroquinolone class[46-49] may play a role as well.

In the absence of acute trauma or overt injury mechanism, ATY will clinically present as gradual pain and stiffness in the midportion of the tendon, 2 to 6 cm proximal to the calcaneal insertion.[8,20,38,42] There may be a history of different or increased physical activity levels that precipitates injury and symptom reporting. In the early stages, tendon pain may be present following a period of inactivity (i.e. sleep, prolonged sitting), which lessens with a brief bout of activity, only to increase again after sustained activity.[9,38] As the condition progresses to a chronic state, tendon pain may be present at rest, and exercise or activity durations are shortened due to earlier onset of pain.[38]

Inspection of a symptomatic achilles tendon may reveal asymmetry, swelling, or abnormal tissue contour. Palpation will reveal tenderness along the tendon, reproducing the patient's pain. If degeneration of the tendon has occurred, a thickened, nodular area may be palpable.[9,42] To gauge the possible impact on foot kinematics, various ranges of motion at the foot and ankle should be assessed.[38,50] It is also important to view the biomechanical alignment of the foot and ankle while the patient is standing and throughout the gait cycle.[9,38,50] A custom foot orthotic may be utilized to correct any aberrant mechanics of the foot and ankle to relieve pain in the Achilles.[20,22,42] In this case, the patient reported that orthotic prescription as a stand alone intervention was not effective in providing a therapeutic or functional benefit.

Achilles tendon rupture should be suspected if there is a history of acute pain after a popping sound in the posterior aspect of the heel, if there is a positive result on the Thompson test[19], and/or if a gap can be palpated within the achilles tendon[9]. Excluding tendon tear or rupture, the differential diagnostic list in patients with posterior ankle pain should include retrocalcaneal bursitis[9,38], insertional achilles tendinopathy[38], posterior ankle impingement[51], achilles tendon ossification[52], and systemic inflammatory disease[45]. Plain radiography may be used as the initial investigative study for suspected achilles tendinopathy. Results are usually normal, but may reveal calcification of the tendon, osteoarthritis, or a loose body.[9] Musculoskeletal ultrasonography and magnetic resonance imaging (MRI) may be helpful in cases where the patient fails to respond to conservative management or the diagnosis remains unclear.[9,38]

Healing of ATY may take several months in chronic conditions[19], and may partially be due to the lack of vascularity to the tendon[42]. Initial conservative treatment measures should begin with relative rest and activity modification to provide pain relief and time for the tendon to heal.[6,11,20,28,42] Medical acupuncture with electrical stimulation was utilized during the in-office treatment sessions to provide pain relief. This was immediately followed by GT applied to the achilles tendon as well as all the affected soft tissues in the right lower extremity identified as tender or dysfunctional during the initial assessment and subsequent treatment sessions. GT is a form of augmented soft tissue mobilization in which stainless steel instruments are utilized to apply controlled microtrauma to the affected soft tissues.[53] Studies suggest that the controlled microtrauma induces healing via fibroblast

proliferation.[54] Additional studies have shown clinical efficacy using GT for the treatment of various soft tissue disorders.[53,55-60]

Eccentric training has garnered considerable attention with respect to rehabilitation of ATY. Several studies suggest that eccentric strength exercises for the calf can improve symptoms and should be initiated early in treatment.[1,25,61,62] It has been hypothesized that eccentric training may be beneficial because of its effect on improving microcirculation[63] and peritendinous type I collagen synthesis[64]. One particular study demonstrated that a 12-week course of eccentric strengthening exercises was more effective than a traditional concentric strengthening program for treating ATY in recreational athletes.[61] In other studies, imaging of the achilles tendon before and after a 12-week eccentric training protocol showed thinning and normalization of the tendon structure both on ultrasound and MRI.[54] Stretching exercises for the gastrocnemius-soleus complex have also been advocated to reduce pain and improve function.[20,25,38,61] In this case, stretching exercises and eccentric calf exercises for both the gastrocnemius and soleus muscle groups were initiated early and well tolerated by the patient.

Additional conservative modalities commonly utilized in the treatment of ATY include therapeutic ultrasound, low level laser therapy, and taping.[38] Other non-operative treatment alternatives include extracorporeal shock wave therapy[65,66], topical glyceryl trinitrate patches[67], and corticosteroid injections[9,68]. Scientific evidence supporting corticosteroid injections is controversial[69], and there is evidence that their use around the achilles tendon increases the risk of rupture[70]. As a result, steroid injection is becoming "obsolete" in the treatment of midportion ATY[71] and is being gradually replaced by new therapies utilizing injections of polidocanol[72], along with autologous whole blood and platelet rich plasma[73,74]. Surgical intervention may be considered for cases that have failed a comprehensive, nonsurgical treatment program of three to six months in duration.[9,20]

There are several factors that may have influenced the favourable outcome of this case study. The patient in this circumstance did not demonstrate any significant co-morbidities that would have complicated recovery or limited her participation in an active exercise program. The patient was extremely motivated to recover and compliance to the scheduled office visits and prescribed exercises was excellent. The use of medical acupuncture points appeared to be effective in decreasing initial pain levels, while at the same time allowed active treatment in the form of static stretching and eccentric heel drops to be introduced early in the treatment protocol. Graston Technique® was useful in decreasing the soft tissue tenderness and dysfunction and theoretically aiding soft tissue healing. To ensure the likelihood of a positive therapeutic outcome, this practitioner also included gluteal and lumbopelvic conditioning, lower extremity flexibility and strength training, and proprioceptive exercises to address the functional deficits in the right lower extremity.

Summary:

Much has been written in the scientific literature about the conservative management of ATY. However, there is no high level of evidence that exists to conclusively support the use of any particular modality for treatment. Interventions that address extrinsic and intrinsic risk factors and focus on returning the patient back to work, sport, and ADLs in a timely manner require further investigation. This should include study in clinical trials with large sample sizes and controls to evaluate short and long term efficacy of various therapeutic modalities. This case demonstrates the successful management of midportion ATY using a variety of conservative interventions that can be employed by chiropractic practitioners. Although favourable results were obtained, it is important to note that the nature of this investigation was that of a case study, and therefore the treatment protocol utilized may not be appropriate for all individuals presenting with ATY. Practitioners treating this type of injury could consider implementing the conservative treatment strategies utilized in this case for other patients presenting with midportion ATY.

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References

1. Khan KM, Cook JL, Bonar F, Harcourt P, Astrom M. Histopathology of common tendinopathies. Update and

implications for clinical management. Sports Med. 1999 Jun;27(6):393–408.
2. Nirschl RP, Ashman ES. Elbow tendinopathy: tennis elbow. Clin Sports Med. 2003 Oct;22(4):813–36.
3. Nirschl RP, Pettrone FA. Tennis elbow. The surgical treatment of lateral epicondylitis. J Bone Joint Surg Am. 1979 Sep;61(6A):832–9.
4. Maffulli N, Khan KM, Puddu G. Overuse tendon conditions: time to change a confusing terminology. Arthroscopy. 1998 Nov-Dec;14(8):840–3.
5. Wilder RP, Sethi S. Overuse injuries: tendinopathies, stress fractures, compartment syndrome, and shin splints. Clin Sports Med. 2004 Jan;23(1):55–81, vi.
6. Rees JD, Maffulli N, Cook J. Management of tendinopathy. Am J Sports Med. 2009 Sep;37(9):1855–67. Epub 2009 Feb 2.
7. Cook JL, Purdam CR. Is tendon pathology a continuum? A pathology model to explain the clinical presentation of load-induced tendinopathy. Br J Sports Med. 2009 Jun;43(6):409–16.
8. van Sterkenburg MN, van Dijk CN. Mid-portion Achilles tendinopathy: why painful? An evidence-based philosophy. Knee Surg Sports Traumatol Arthrosc. 2011 Aug;19(8):1367–75.
9. Simpson MR, Howard TM. Tendinopathies of the foot and ankle. Am Fam Physician. 2009 Nov 15;80(10):1107–14.
10. Longo UG, Ronga M, Maffulli N. Achilles tendinopathy. Sports Med Arthrosc. 2009 Jun;17(2):112–26.
11. Murrell GA. Understanding tendinopathies. Br J Sports Med. 2002 Dec;36(6):392–3.
12. Leadbetter WB. Cell-matrix response in tendon injury. Clin Sports Med. 1992 Jul;11(3):533–78.
13. Knobloch K, Kraemer R, Lichtenberg A, Jagodzinski M, Gossling T, Richter M, Zeichen J, Hufner T, Krettek C. Achilles tendon and paratendon microcirculation in midportion and insertional tendinopathy in athletes. Am J Sports Med. 2006 Jan;34(1):92–7.
14. Andersson G, Danielson P, Alfredson H, Forsgren S. Nerve-related characteristics of ventral paratendinous tissue in chronic Achilles tendinosis. Knee Surg Sports Traumatol Arthrosc. 2007 Oct;15(10):1272–9.
15. Lake JE, Ishikawa SN. Conservative treatment of Achilles tendinopathy: emerging techniques. Foot Ankle Clin. 2009 Dec;14(4):663–74.
16. 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 Mar;35(3):374–83.
17. Magnussen RA, Dunn WR, Thomson AB. Nonoperative treatment of midportion Achilles tendinopathy: a systematic review. Clin J Sport Med. 2009 Jan;19(1):54–64.
18. Petersen W, Welp R, Rosenbaum D. Chronic Achilles tendinopathy: a prospective randomized study comparing the therapeutic effect of eccentric training, then AirHeel brace, and a combination of both. Am J Sports Med. 2007 Oct;35(10):1659–67.
19. Mazzone MF, McCue T. Common conditions of the achilles tendon. Am Fam Physician. 2002 May 1;65(9):1805–10.
20. Maffulli N, Sharma P, Luscombe KL. Achilles tendinopathy: aetiology and management. J R Soc Med. 2004 Oct;97(10):472–6.
21. Holmes GB, Lin J. Etiologic factors associated with symptomatic achilles tendinopathy. Foot Ankle Int. 2006 Nov;27(11):952–9.
22. Scott A, Huisman E, Khan K. Conservative treatment of chronic Achilles tendinopathy. CMAJ. 2011 Jul 12;183(10):1159–65.
23. Alfredson H, Cook J. A treatment algorithm for managing Achilles tendinopathy: new treatment options. Br J Sports Med. 2007 Apr;41(4):211–6.
24. Paavola M, Kannus P, Paakkala T, Pasanen M, Järvinen M. Long-term prognosis of patients with achilles tendinopathy. An observational 8-year follow-up study. Am J Sports Med. 2000 Sep-Oct;28(5):634–42.
25. Alfredson H, Pietilä T, Jonsson P, Lorentzon R. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. Am J Sports Med. 1998 May-Jun;26(3):360–6.
26. 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. Am J Sports Med. 2011 Mar;39(3):607–13. Epub 2010 Nov 17.
27. Krämer R, Lorenzen J, Vogt PM, Knobloch K. [Systematic review about eccentric training in chronic achilles tendinopathy]. Sportverletz Sportschaden. 2010 Dec;24(4):204–11.
28. Alfredson H, Lorentzon R. Chronic Achilles tendinosis: recommendations for treatment and prevention. Sports Med. 2000 Feb;29(2):135–46.
29. Ohberg L, Lorentzon R, Alfredson H. Eccentric training in patients with chronic Achilles tendinosis: normalised tendon structure and decreased thickness at follow up. Br J Sports Med. 2004 Feb;38(1):8–11; discussion 11.
30. Sayana MK, Maffulli N. Eccentric calf muscle training in non-athletic patients with Achilles tendinopathy. J Sci Med Sport. 2007 Feb;10(1):52–8.
31. Maffulli N, Testa V, Capasso G, Oliva F, Sullo A, Benazzo F, Regine R, King JB. Surgery for chronic Achilles tendinopathy yields worse results in nonathletic patients. Clin J Sport Med. 2006 Mar;16(2):123–8.
32. Fahlstrom M, Jonsson P, Lorentzon R, Alfredson H. Chronic Achilles tendon pain treated with eccentric calf-muscle training. Knee Surg Sports Traumatol Arthrosc. 2003;11:327–333.
33. Christensen MG, Delle Morgan DR. Job analysis of chiropractic: a project report, survey analysis, and

summary of the practice of chiropractic within the United States. Greeley (Colo): National Board of Chiropractic Examiners; 1993. p. 78.
34. Pfefer MT, Cooper SR, Uhl NL. Chiropractic management of tendinopathy: a literature synthesis. J Manipulative Physiol Ther. 2009 Jan;32(1):41–52.
35. Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. North American Orthopaedic Rehabilitation Research Network. Phys Ther. 1999 Apr;79(4):371–83.
36. Saltzman CL, Tearse DS. Achilles tendon injuries. J Am Acad Orthop Surg. 1998 Sep-Oct;6(5):316–25.
37. O'Brien M. The anatomy of the Achilles tendon. Foot Ankle Clin. 2005 Jun;10(2):225–38.
38. Carcia CR, Martin RL, Houck J, Wukich DK; Orthopaedic Section of the American Physical Therapy Association. Achilles pain, stiffness, and muscle power deficits: achilles tendinitis. J Orthop Sports Phys Ther. 2010 Sep;40(9):A1–26.
39. Schepsis AA, Jones H, Haas AL. Achilles tendon disorders in athletes. Am J Sports Med. 2002;30:287–305.
40. Galloway MT, Jokl P, Dayton OW. Achilles tendon overuse injuries. Clin Sports Med. 1992 Oct;11(4):771–82.
41. Jones DC. Tendon Disorders of the Foot and Ankle. J Am Acad Orthop Surg. 1993 Nov;1(2):87–94.
42. Chinn L, Hertel J. Rehabilitation of ankle and foot injuries in athletes. Clin Sports Med. 2010 Jan;29(1):157–67, table of contents.
43. Khan KM, Maffulli N. Tendinopathy: an Achilles' heel for athletes and clinicians. Clin J Sport Med. 1998 Jul;8(3):151–4.
44. Posthumus M, Collins M, Cook J, et al. Components of the transforming growth factor-β family and the pathogenesis of human Achilles tendon pathology: a genetic association study. Rheumatology (Oxford) 2010;49:2090–7.
45. Ames PR, Longo UG, Denaro V, Maffulli N. Achilles tendon problems: not just an orthopaedic issue. Disabil Rehabil. 2008;30(20–22):1646–50.
46. Paavola M, Kannus P, Järvinen TA, Khan K, Józsa L, Järvinen M. Achilles tendinopathy. J Bone Joint Surg Am. 2002;84–A(11):2062–2076.
47. Corps AN, Curry VA, Harrall RI, Dutt D, Hazleman BL, Riley GP. Ciprofloxacin reduces the stimulation of prostaglandin E(2) output by interleukin-1beta in human tendon-derived cells. Rheumatology (Oxford) 2003;42:1306–10.
48. Doyle HE. Tendinopathy resulting from the use of fluoroquinolones: managing risks. JAAPA. 2010 Dec;23(12):18–21, 54.
49. Hall MM, Finnoff JT, Smith J. Musculoskeletal complications of fluoroquinolones: guidelines and precautions for usage in the athletic population. PM R. 2011 Feb;3(2):132–42.
50. Silbernagel KG, Gustavsson A, Thomeé R, Karlsson J. Evaluation of lower leg function in patients with Achilles tendinopathy. Knee Surg Sports Traumatol Arthrosc. 2006 Nov;14(11):1207–17.
51. Sanders TG, Rathur SK. Impingement syndromes of the ankle. Magn Reson Imaging Clin N Am. 2008 Feb;16(1):29–38, v.
52. Richards PJ, Braid JC, Carmont MR, Maffulli N. Achilles tendon ossification: pathology, imaging and aetiology. Disabil Rehabil. 2008;30(20–22):1651–65.
53. Hammer WI. The effect of mechanical load on degenerated soft tissue. J Bodyw Mov Ther. 2008 Jul;12(3):246–56. Epub 2008 Jun 3.
54. Gehlsen GM, Ganion LR, Helfst R. Fibroblast responses to variation in soft tissue mobilization pressure. Med Sci Sports Exerc. 1999 Apr;31(4):531–5.
55. Hammer WI, Pfefer MT. Treatment of a case of subacute lumbar compartment syndrome using the Graston technique. J Manipulative Physiol Ther. 2005 Mar-Apr;28(3):199–204.
56. Burke J, Buchberger DJ, Carey-Loghmani MT, Dougherty PE, Greco DS, Dishman JD. A pilot study comparing two manual therapy interventions for carpal tunnel syndrome. J Manipulative Physiol Ther. 2007 Jan;30(1):50–61.
57. Howitt S, Wong J, Zabukovec S. The conservative treatment of Trigger thumb using Graston Techniques and Active Release Techniques. J Can Chiropr Assoc. 2006 Dec;50(4):249–54.
58. Howitt S, Jung S, Hammonds N. Conservative treatment of a tibialis posterior strain in a novice triathlete: a case report. J Can Chiropr Assoc. 2009 Mar;53(1):23–31.
59. Black DW. Treatment of knee arthrofibrosis and quadriceps insufficiency after patellar tendon repair: a case report including use of the graston technique. Int J Ther Massage Bodywork. 2010 Jun 23;3(2):14–21.
60. Looney B, Srokose T, Fernández-de-las-Peñas C, Cleland JA. Graston instrument soft tissue mobilization and home stretching for the management of plantar heel pain: a case series. J Manipulative Physiol Ther. 2011 Feb;34(2):138–42.
61. 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 Surg Sports Traumatol Arthrosc. 2001;9(1):42–7.
62. Silbernagel KG, Thomeé R, Thomeé P, Karlsson J. Eccentric overload training for patients with chronic Achilles tendon pain – a randomised controlled study with reliability testing of the evaluation methods. Scand J Med Sci Sports. 2001 Aug;11(4):197–206.
63. Knobloch K, Kraemer R, Jagodzinski M, Zeichen J, Meller R, Vogt PM. Eccentric training decreases paratendon capillary blood flow and preserves paratendon oxygen

saturation in chronic achilles tendinopathy. J Orthop Sports Phys Ther. 2007 May;37(5):269–76.
64. Knobloch K. Eccentric rehabilitation exercise increases peritendinous type I collagen synthesis in humans with Achilles tendinosis. Scand J Med Sci Sports. 2007 Jun;17(3):298–9.
65. Wilson M, Stacy J. Shock wave therapy for Achilles tendinopathy. Curr Rev Musculoskelet Med. 2010 Nov 26;4(1):6–10.
66. Vulpiani MC, Trischitta D, Trovato P, Vetrano M, Ferretti A. Extracorporeal shockwave therapy (ESWT) in Achilles tendinopathy. A long-term follow-up observational study. J Sports Med Phys Fitness. 2009 Jun;49(2):171–6.
67. Paoloni JA, Murrell GA. Three-year follow-up study of topical glyceryl trinitrate treatment of chronic non-insertional Achilles tendinopathy. Foot Ankle Int. 2007 Oct;28(10):1064–8.
68. Coombes BK, Bisset L, Vicenzino B. Efficacy and safety of corticosteroid injections and other injections for management of tendinopathy: a systematic review of randomised controlled trials. Lancet. 2010 Nov 20;376(9754):1751–67.
69. Speed CA. Fortnightly review: Corticosteroid injections in tendon lesions. BMJ. 2001 Aug 18;323(7309):382–6
70. Gill SS, Gelbke MK, Mattson SL, Anderson MW, Hurwitz SR. Fluoroscopically guided low-volume peritendinous corticosteroid injection for Achilles tendinopathy. A safety study. J Bone Joint Surg Am. 2004 Apr;86–A(4):802–6.
71. van Sterkenburg MN, van Dijk CN. Injection treatment for chronic midportion Achilles tendinopathy: do we need that many alternatives? Knee Surg Sports Traumatol Arthrosc. 2011 Apr;19(4):513–5.
72. Lind B, Ohberg L, Alfredson H. Sclerosing polidocanol injections in mid-portion Achilles tendinosis: remaining good clinical results and decreased tendon thickness at 2-year follow-up. Knee Surg Sports Traumatol Arthrosc. 2006 Dec;14(12):1327–32. Epub 2006 Sep 12.
73. Kampa RJ, Connell DA. Treatment of tendinopathy: is there a role for autologous whole blood and platelet rich plasma injection? Int J Clin Pract. 2010 Dec;64(13):1813–23.
74. Soomekh DJ. Current concepts for the use of platelet-rich plasma in the foot and ankle. Clin Podiatr Med Surg. 2011 Jan;28(1):155–70.