Journal of Physiotherapy 68 (2022) 221–237

Journal of PHYSIOTHERAPY

journal homepage: www.elsevier.com/locate/jphys

Research

Physiotherapy management of Achilles tendinopathy

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KEYWORDS

Achilles tendinopathy
Physical therapy
Biopsychosocial
Stretch-shorten cycle

[Malliaras P (2022) Physiotherapy management of Achilles tendinopathy. *Journal of Physiotherapy* 68:221–237]

Introduction

This review focuses on two distinct but related conditions: midportion Achilles tendinopathy and insertional Achilles tendinopathy. They are characterised by localised pain (Figure 1) and impaired locomotor function, including walking, running and jumping. The information mainly pertains to midportion tendinopathy, which dominates the literature, but evidence about insertional Achilles tendinopathy is highlighted. Although discussed briefly within differential diagnosis, Achilles tendon rupture and partial tears are not the focus. Exercise is a primary recommended treatment, along with education and advice; therefore, physiotherapists have an important role in managing Achilles tendinopathy. After outlining the epidemiology, burden and clinical course of Achilles tendinopathy, this review focuses on current considerations in its diagnosis, assessment and management from a physiotherapy perspective. A theme throughout the review is a shift from a reductionist biomedical view towards a biopsychosocial view of Achilles tendinopathy, emphasising how this shapes current clinical care.

Terminology

Participants in a recent international symposium about the condition agreed that the term Achilles tendinopathy is most appropriate.[1] Labels such as tendinitis and tendinosis are discouraged because: they imply specific biological processes that are currently debated and unclear; they may erroneously imply that certain treatments like rest may be sufficient for recovery; and the use of multiple terms among clinicians, the literature and other sources (eg, the internet) contributes to confusion and mistrust among patients.[1]

Epidemiology

Achilles tendinopathy is very common among people involved in running and running sports but can impact people who are less active. Between 6 and 10% of runners are affected by Achilles tendinopathy at any one time.[2] The lifetime prevalence is 52% for middle-distance and long-distance runners, 36% for runners of shorter distances, 24% for athletes in general and 6% for the general population.[3] Between two and three patients per 1,000 in Dutch general practice have Achilles tendinopathy, and two-thirds are not classified as athletes.[4]

A large database study (20 million records) found that men and women are equally affected by Achilles tendinopathy and the peak age for incidence is from 40 to 59 years.[5] Midportion Achilles tendinopathy is reported to be more common than insertional Achilles tendinopathy[6,7] and about one in three people report bilateral symptoms.[8,9]

Achilles tendinopathy is considered an overuse injury, meaning that activity (and thereby tendon load) is an important extrinsic causative factor.[10] Walking, running and jumping are implicated because they involve a rapid stretch-shorten cycle of the muscle-tendon unit and repetitive high Achilles tendon force and strain (eg, five to seven times body weight per stride and up to 6% strain during running).[11-15] A sudden change in stretch-shorten cycle activities (eg, rapid increase in weekly running mileage or introduction of hill running or higher intensity track sessions) that exceeds physiological adaptive capacity is implicated in most cases[16-18] and this is likely related to slow adaptation of tendon compared with muscle.[19-21]

Compression of the insertion of the Achilles tendon against the calcaneum may occur in extreme ranges of ankle dorsiflexion and is considered a risk factor for development of insertional tendinopathy.[22] Compression in dorsiflexion during the stretch-shorten cycle (as may occur when running up a hill) seems to be a particular issue. It is rare for a tendinopathy to manifest from compression alone (eg, stretching into ankle dorsiflexion). Consideration should be given to sporting or daily movement patterns that involve excessive ranges of dorsiflexion during the stretch-shorten cycle (eg, running backwards and changing direction as is common in some football codes).

Intrinsic factors moderate the risk profile and are more common among less active people who develop tendinopathy.[23] Evidence-based prospective predictive factors include prior lower limb tendinopathy or fracture, use of fluroquinolone antibiotics, moderate alcohol use, training in cold weather, and decreased isokinetic plantar flexor strength.[24] Pathology precedes and is a weak predictive factor for the onset of pain.[25] This adds complexity because some factors may contribute to pathology but not pain, or vice versa, explaining

https://doi.org/10.1016/j.jphys.2022.09.010

Figure 1. Site of pain in Achilles tendinopathy.

why pain manifests differently in individuals with seemingly similar risk profiles. Clinically, it is helpful to consider factors that may influence tissue load (eg, activity, body weight), tissue homeostasis and adaptive potential (eg, age) and other biopsychosocial factors that may influence pain onset.

Burden of Achilles tendinopathy

People with Achilles tendinopathy can experience a profound impact on their quality of life that seems to be rooted in a loss of identity because they are unable to undertake social and sporting activities that are important to them.[26-29] Consistent with this, a recent cohort study found that most participants with Achilles tendinopathy reported quality of life impacts in relation to mobility (66%), usual activity (50%) and pain/discomfort (89%) impairments.[30] In contrast, only 1% and 20% reported impact on self-care and anxiety/depression, respectively.[30] There was reduced work productivity among 38% of participants (comparable with moderately severe knee osteoarthritis) and direct treatment and lost productivity costs were estimated to be AUD $1,396.[30] Reduced mobility related to Achilles tendinopathy is likely to result in adverse consequential effects on general health, especially among older people.[31]

Clinical course and natural history

Based on one trial, only 24% of participants exposed to a wait-and-see intervention for midportion Achilles tendinopathy were classified as recovered.[32] Exercise interventions resulted in an average improvement of 20 points in composite pain and disability (clinically meaningful benefit is 14 points) over 12 weeks[33] but there are reports that between 44%[34] and 75% of people[35] may not respond. Further improvements in symptoms are likely between 12 and 52 weeks but not beyond this time.[36,37] Mild symptoms may persist among 60% and 25% at 5 and 10 years, respectively.[38,39]

Persistence of symptoms is also an issue with athletes, as well as recurrence and reduced performance. Among a cohort of 1,929 runners, 5% developed Achilles pain training for a running event and 32% had persisting symptoms at 52 weeks.[36] Among elite soccer players, time-loss related to Achilles tendinopathy is low (median of 10 days) but recurrence is high (27%) and more likely if sport cessation is < 10 days.[40] Time loss fails to capture performance impact, which is a larger issue because many athletes with Achilles tendinopathy continue to compete.[41]

Diagnosis

Achilles tendinopathy is primarily diagnosed based on a detailed patient history and clinical assessment.[10,42-44] When questioned about the location of pain, patients either pinch the midportion of the tendon with two fingers (2 to 6 cm above the calcaneum) or point to a localised area at the posterior calcaneum (Figure 1). Most can recall a change in loading activity coinciding with the onset of pain. Increase in pain severity and impact on function are typically gradual. Initially people report minor symptoms (pain or stiffness) upon weight-bearing after prolonged rest or sleep (referred to as 'morning stiffness' or 'arising pain') or pain upon commencing walking or running that improves after a few minutes (referred to as the 'warm-up' phenomenon). As severity progresses, symptoms are reported for several hours or even days following bouts of activity and ultimately they persist throughout active periods and severely limit them. Diagnosis is aided by appreciating that activities that provoke Achilles tendon pain will most likely be stretch-shorten cycle loads such as walking, running and sports involving running and jumping.

Clinical tests have unknown value for diagnosing painful Achilles tendinopathy, as imaging pathology (which is commonly asymptomatic[45]) is used as the reference standard, and intra-rater and inter-rater reliability are variable.[46-48] The issue with imaging used as a reference standard is that people with asymptomatic pathology will be positive on this reference standard even though they do not have a painful variant of the condition (so will test negative on other tests). Reproducing localised midportion or insertional Achilles pain with loading tests such as the calf raise or hop tasks on one leg is a hallmark of Achilles tendinopathy diagnosis. The issue is that load tests may be negative in less severe presentations.[49] More progressive load test options are shown in Figure 2. Pain into compression (eg, extreme dorsiflexion position during calf raise/drop over a step) is often more painful than submaximal hopping for insertional Achilles tendinopathy (vice versa for midportion). Localised tendon thickening or swelling with palpation are surrogates of (potentially asymptomatic[45]) pathology and therefore only helpful in the presence of other clinical features. Tenderness on palpation is of limited value (palpation may be tender in people with and without tendon pain[50]) but raises suspicion of a differential diagnosis when absent. The Arc sign and London Hospital test are disease-specific tests but have limited diagnostic utility.[46-48]

Achilles tendon imaging pathology is common in people without any symptoms.[41,51] For example, up to 45% of people without pain have intratendinous abnormalities and up to 51% have thickening, with substantial variation between cohorts that is partially explained by age, physical activity and body mass index.[41] The prevalence of asymptomatic pathology means that a diagnosis based on imaging alone may be incorrect and lead to unnecessary healthcare interventions,[52] and confirming symptomatic Achilles tendinopathy with imaging is unnecessary.[44] Imaging may, however, be indicated after non-response to initial recommended treatments and to confirm suspected differential diagnoses.

Figure 3 describes common differential diagnoses.[42,53] Pathology features such as Haglund's deformity and retrocalcaneal bursitis are encompassed within insertional Achilles tendinopathy and have overlapping symptoms. They are managed with non-tissue-specific (often imaging has not been performed so the tissue features are unknown) primary treatments for Achilles tendinopathy based on the clinical presentation (outlined below). Other conditions have a distinct symptom presentation and some of these can overlap with Achilles tendinopathy and others are separate (Figure 3). Their presence is appreciated based on clinical history and examination (eg, paratenonitis often presents as diffuse midportion tendon pain and tendon movement may evoke crepitus).[48] In some instances, imaging may be indicated to confirm a differential diagnosis if it will help to implement appropriate treatment (eg, anti-inflammatory approaches in the case of paratenonitis).

In the presence of symptoms following sudden high Achilles load (eg, sprinting across the road), it is crucial to be alert to red flags such as tendon rupture (characterised by plantarflexor dysfunction and a positive Thompson test[48]) or a substantial acute tear (characterised by severe pain and plantarflexor dysfunction).[42] People with painful Achilles tendinopathy rarely progress to a frank tendon tear or rupture,[5] but asymptomatic Achilles tendinopathy is a prerequisite

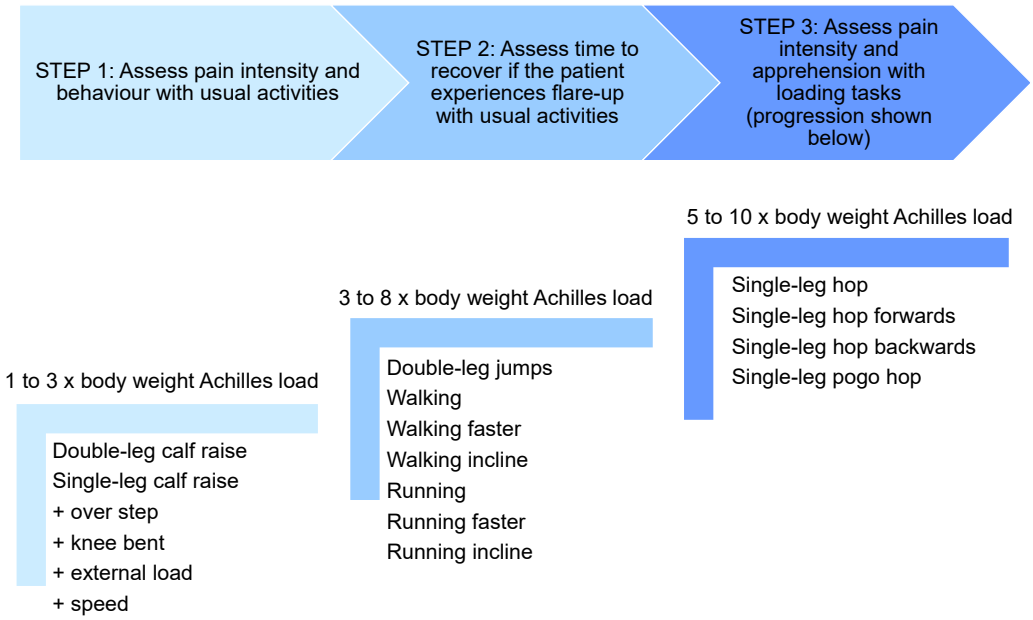

Figure 2. Steps in assessment of load tolerance.
Force values based on unpublished data from Sancho et al.

for these conditions.[54] Identifying tears on imaging is a current enigma, probably because a range of pathologies can occur in the absence of pain[45] so imaging cannot be relied on to confirm recent structural tendon changes. Clinicians need to be alert to the possibility of inflammatory arthropathy.[42] Suspicion of inflammatory arthropathy is increased when there are sudden bilateral and severe symptoms following no obvious change in activity or very poor response or aggravation with low-intensity exercise interventions.

Assessment

Load tolerance

Examination of pain severity and response with Achilles tendon loading (or load tolerance) is an important part of assessment; it guides activity modification and exercise prescription and progression advice in tendinopathy.[10,55] Load tolerance assessment involves three components (Figure 2): assess self-reported pain intensity during Achilles tendon loading activities; if the pain increases after these activities, assess how long it takes to return to pre-loading pain levels; and assess self-reported pain intensity on a pain rating scale during a progressive loading task. These are the same load tests used to reproduce localised pain for diagnostic purposes. For load tolerance purposes pain intensity is also assessed to guide activity modification and exercise prescription. Numerical rating scales are commonly used, with pain rated up to 5 out of 10 suggested to be acceptable.[9,56] This scale is not universally acceptable so a graded chronic pain scale (eg, mild, moderate, severe) may be more patient-centred.[57] Achilles tendinopathy pain is thought to be load-dependent[4,58] and the pain response is generally proportional to load; however, pain is not a surrogate for load because of other biopsychosocial influences on pain.[59,60]

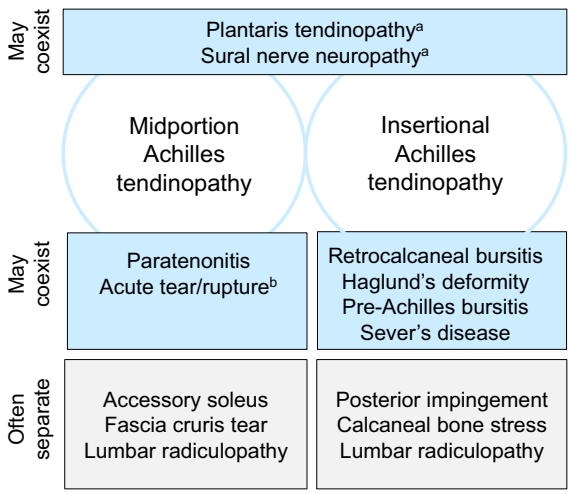

Figure 3. Differential diagnoses for midportion and insertional Achilles tendinopathy.
[a] Plantaris and sural nerve presentations are not site specific.
[b] Acute tear/rupture occurs on background of asymptomatic Achilles tendinopathy.

Self-reported impairments

Considering biopsychosicial factors in assessment (Table 1), guided by current evidence,[24] helps to identify impairments and potential contributors and guides patient-centred management. In the tendinopathy literature, physical (eg, strength and biomechanics) impairments have been extensively investigated,[61-64] with greater attention more recently on psychological factors[65-67] and the lived experience.[26-29] Given that Achilles tendinopathy presentation is heterogeneous, biopsychosocial impairments are only seen in some people.[65]

An appreciation of hallmark impacts of Achilles tendinopathy can be gained by assessing key outcome domains. This includes pain and disability, or combinations of these, as in the validated and disease-specific Victorian Institute of Sport Assessment-Achilles (VISA-A).[68] Participation can be assessed clinically by asking about modification of usual daily, leisure or sports activities that involve walking and running, and appreciating whether these modifications are justified given the pain and disability levels, or indicating maladaptive coping (ie, activity endurance or fear-avoidance).[69] Quality of life can be explored with open questions about overall impact (cueing for emotional, mobility and social aspects) that can be explored further with formal assessment or questioning (Table 1).

A careful history may reveal relevant features that may contribute to the condition or prolong recovery. Long symptom duration is often associated with multiple failed treatments and conflicting advice from multiple clinicians, and this can lead to frustration and reduced outcome expectation. It is particularly important to consider how prior imaging has been perceived and may influence beliefs and behaviours. General health (eg, elevated low-density lipoprotein cholesterol) and lifestyle factors (eg, diet, sleep, and general exercise and physical activity) may be relevant.

Table 1
Biopsychosocial aspects of assessment.

Domain	Assessment considerations	Link to Achilles tendinopathy	Further context about the assessment or evidence linking to Achilles tendinopathy
Key Outcome Domains			
Pain with activity/loading[a]	• Pain with calf raise or hop tests	81,153	• Most common pain assessment in Achilles tendinopathy • Distinct information to disability[49] • MCID 10 points[155,b]
Pain over a specific time[a]	• Pain over last 7 days	81,153	
Pain and disability[a]	• Victorian Institute of Sport Assessment	81,153	• Most common disability assessment in Achilles tendinopathy • MCID 14 points[156] • Less relevant for non-athletic people[68,157,158]
Participation[a]	• Participation in running, sport or usual walking	59,81,153	• Low participation despite low pain or high participation despite high pain may indicate maladaptive coping
Quality of life impact[a]	• Open questions about impact on mobility, social life, emotions	81,153	• May indicate need for more detailed assessment of certain domains such as emotions
Biological and Physical			
Demographic, general health	• Obesity (body mass index > 30)	24	• Not a risk factor but conflicting cross-sectional association
	• Older age and female gender	24	• Conflicting evidence they are risk factors
	• Elevated triglycerides or LDL cholesterol or lowered HDH cholesterol	159-161	• Cross-sectional association with Achilles tendinopathy
	• Hypertension	162	• Cross-sectional association with Achilles tendinopathy
	• Hormone replacement • Contraceptive pill use	162 162	• Cross-sectional association with Achilles tendinopathy. HRT may help musculoskeletal pain in menopause[163] so association may be because people with more severe menopause opt for HRT
	• Perimenopausal status or amenorrhea	164	• Indirect basic science evidence that loss of oestrogen negatively effects tendon metabolism
	• History of severe mental health illness	None	• No direct evidence • May require multidisciplinary team input
History	• Other tendinopathies/pain conditions	165	• Prior lower-limb tendinopathy is a risk factor
	• Long duration of symptoms • Multiple failed treatments • Multiple clinicians (with inconsistent advice)	23,26,28,29	• Evidence from qualitative studies • Consider outcome expectations and secondary impairments (eg, frustration, physical impairments, pain mechanism)
	• Imaging pathology perceived as severe	166	• No direct evidence • May relate to fear of movement
	• Family history of Achilles tendinopathy	167	• Possible genetic predisposition
Medications	• Fluoroquinolone antibiotics	24	• Risk factor
Pain mechanisms	• PainDETECT questionnaire • Diffuse mechanical hyperalgesia	168 77,79	• Cross-sectional association • Conflicting cross-sectional association
Physical function capacity[a]	• Standing calf raise test	61,62 153 70	• Cross-sectional association • Most common PFC assessment in Achilles tendinopathy • Normative data among healthy people
	• Seated calf raise 6 repetition maximum	24,61,62 74	• Reduced maximal strength is a risk factor • Reliability among recreational runners with Achilles tendinopathy
	• Hip abduction and extension dynamometry	73,74 74	• Conflicting cross-sectional association • Reliability among recreational runners with Achilles tendinopathy
	• Knee extension 6 repetition maximum	74 74	• Cross-sectional association • Reliability among recreational runners with Achilles tendinopathy
	• Submaximal hop height or plyometric quotient	62,64	• Cross-sectional association • Contact or jump mat required
	• Submaximal hop duration	74	• Cross-sectional association
	• Single or triple hop for distance	169,170	• Cross-sectional association
Range of motion	• Weight-bearing ankle dorsiflexion range of motion	24	• Conflicting risk factor evidence for increased and decreased range

Table 1 (*Continued*)

Domain	Assessment considerations	Link to Achilles tendinopathy	Further context about the assessment or evidence linking to Achilles tendinopathy
Psychological			
Fear of movement and catastrophising[a]	• Tampa Scale of Kinesiophobia-11 (TSK-11) • Pain catastrophising scale	37,153,171,172 155 155	• Conflicting evidence that kinesiophobia predicts outcomes, and no direct evidence for catastrophising (relevant for some subgroups) • Convergent validity TSK-11 • 11 to 22 (minimal), 23 to 28 (low), 29 to 35 (moderate), 36 to 44 (high)
	• Apprehension/unwilling to complete load tests	155	• Kinesiophobia associated with unwillingness to complete load tests
	• High expected pain during hops and calf raise	155	• Kinesiophobia associated with higher expected load test pain
	• Belief that activity may lead to damage or rupture	27-29	• Evidence from qualitative studies
	• Belief need to rest/protect the tendon	28,29	• Evidence from qualitative studies
Outcome expectations	• How much do you expect your Achilles problem to change as a result of the treatment? (Likert scale)	82,84,173	• Preliminary evidence that may predict outcome from a feasibility study
	• Belief may not overcome the problem	29	• Evidence from qualitative studies
	• Belief that exercise may be damaging	28	• Evidence from qualitative studies
Self-efficacy[a]	• Pain self-efficacy questionnaire	153,171	• No direct evidence (relevant for some subgroups)
	• Feeling not in control of symptoms	29	• Evidence from qualitative studies
Emotion[a]	• Hospital anxiety and depression scale	153,171	• No direct evidence (relevant for some subgroups)
	• Negative emotions from loss of mobility	29	• Evidence from qualitative studies
Social and Lifestyle			
Social support	• Consider social circumstances and lifestyle in developing treatment plan	27	• Evidence from qualitative studies
Social wellbeing	• Consider how mobility may impact on social participation and wellbeing	27-29	• Evidence from qualitative studies
Activity levels	• Quantify current walking (eg, steps/day) sports or running (frequency and volume)	24	• Not a risk factor but conflicting cross-sectional associations
Other lifestyle	• Moderate alcohol use	165	• Risk factor
	• Sleep and diet	None	• No direct evidence

HDL = high-density lipoprotein, HRT = hormone-replacement therapy, LDL = low-density lipoprotein, MCID = minimum clinically important difference, PFC = physical function capacity, TSK-11 = Tampa Scale of Kinesiophobia-11.
Validated outcomes measures are shaded blue.
[a] Recommended outcomes by ICON consensus.[81]
[b] Calculated from cross-sectional data rather than prospectively from actual change in pain data.

Fear of movement can be identified via apprehension or unwillingness to undertake tasks that are perceived as threatening or provocative, or via the validated Tampa Scale of Kinesiophobia. Beliefs that can drive fear of movement and poor outcome expectations should be considered. Some patients will benefit from formal assessment of pain self-efficacy or emotional aspects if open questions suggest that these impairments may be present. Social impact may include a loss of self and social relationships stemming from an inability to engage in self-defining and social pursuits involving walking and running. This highlights the importance of a patient-centred approach to understand and address these impacts within the treatment process.

Physical examination of impairments

Physical examination (Table 1) should include multidimensional calf muscle capacity, including endurance tests such as the standing calf raise, which is clinically accessible, but also strength under load (which is more closely related to maximal strength).[61,62] This is important because maximal strength appears to be more impaired (16 to 44%) than endurance (8%) (note that this literature either uses the unaffected or healthy controls as a comparator).[62] The opposite or less affected side is often stronger but may still be impaired[61,62] so it is preferable to use normative data as a target. Demonstration of objective strength impairments compared to normative data (available for calf raise endurance test[70]) or population-specific data among health comparator groups (Table 1) can motivate patients to engage with exercise interventions. The soleus has the largest physiological cross-sectional area of all the calf muscles (three times greater than medial and six times larger than lateral gastrocnemii[71]) so consideration should also be given to assessment of calf capacity in knee-straight positions (soleus and gastrocnemius are activated equally) and knee-bent positions (biased towards soleus activation).[72] Global lower-limb strength impairments should be considered[73,74] guided by history of prior lower-limb injury.

Power impairments are common and can be assessed objectively in a clinical setting via: hop height or plyometric quotient (using a contact or jump mat) during submaximal cyclical hopping; or single or triple hop for distance.[62] To minimise the risk of pain flare up, power assessment should be undertaken when pain is acceptable. For some people, obvious strategies to reduce Achilles load can be observed, including landing with the foot flat rather than on the toes or landing on the toes but with minimal ankle absorption through dorsiflexion. Clinicians should note apprehension with power assessments, as this can guide rehabilitation progression (see graded exposure approach below).

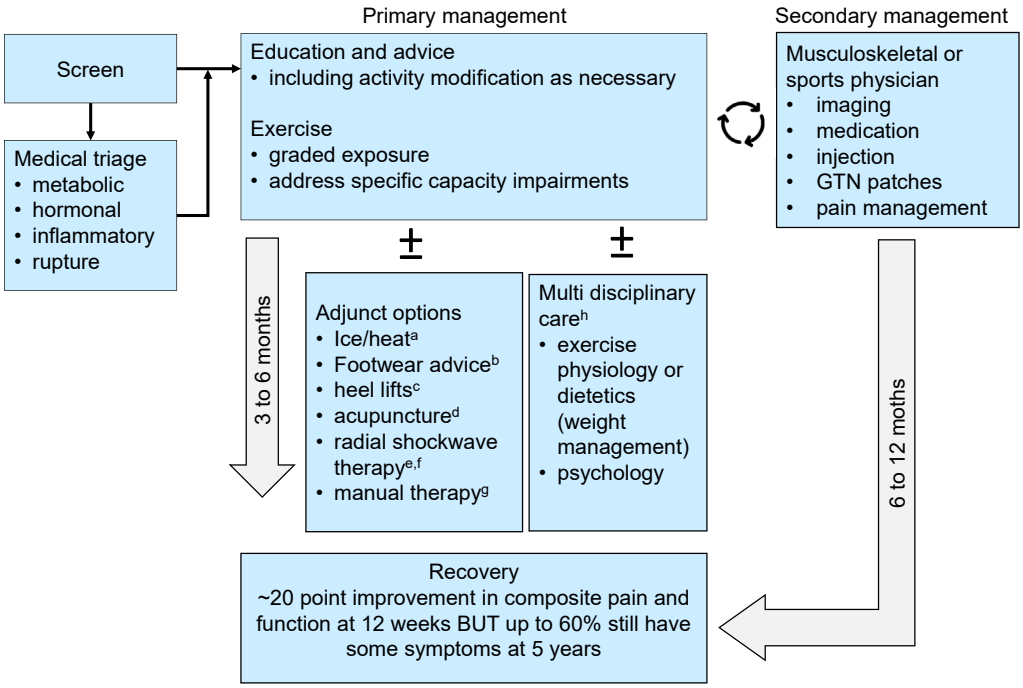

Figure 4. Achilles tendinopathy management process informed by evidence and clinical reasoning.
[a] No direct evidence but possible short-term effects on pain/comfort.
[b] No direct evidence but advice about appropriate shoes often helpful (see text).
[c] Evidence (conflicting) as an alternative treatment for midportion Achilles tendinopathy.
[d] Evidence as an alternative treatment for midportion Achilles tendinopathy.
[e] Evidence (conflicting) as an alternative treatment for insertional Achilles tendinopathy.
[f] Evidence (conflicting) as an adjunct treatment for midportion Achilles tendinopathy.
[g] Evidence (conflicting) for adding instrumented manual therapy to exercise for insertional Achilles tendinopathy.
[h] Based on biopsychosocial factors that may impact on Achilles tendinopathy.
Note: conflicting evidence treatments made it onto this figure if a majority of outcomes at a given timepoint showed a positive effect.

Restricted calf muscle flexibility or restricted or hypermobile ankle dorsiflexion range should be considered in weight-bearing. Slow eccentric phase isotonic calf exercise can be prescribed to target calf flexibility impairment.[75] Although dynamic ankle eversion does not appear to be related to Achilles tendinopathy,[64] running analysis (on a treadmill or outside based on patient preference) may detect reduced ankle dorsiflexion in midstance (possibly an adaptive response to reduce load),[64] or other impairments (eg, running with low cadence, which may increase ankle dorsiflexion excursion). Increased running cadence (5% above preferred) may reduce Achilles stress.[76]

The pain mechanisms should be considered (Table 1). Consistent with local nociceptive pain, quantitative sensation testing suggests an absence of diffuse mechanical hyperalgesia[77] and spreading pain is uncommon. Nevertheless, central features may be present among some people,[78,79] which can be appreciated with questionnaires (painDETECT) or clinical proxies (such as diffuse mechanical hyperalgesia and spreading pain) and may then indicate the need for appropriate mechanism-based treatment.[80]

Outcome measures

Outcome measurement is guided by recent international expert and patient consensus on core outcome domains for tendinopathy.[81] This should include pain with loading and over specific time, as well as pain and disability outcomes (Table 1); global rating of change is also recommended because it is simple and acceptable to patients.[81] Other psychological outcomes (eg, fear of movement, pain self-efficacy and emotion) can also be assessed over time if found to be impaired.

Management

Considerations for physiotherapy management of a person with Achilles tendinopathy are outlined in Figure 4. Screening and assessment will identify people who may need medical management via their general practitioner or onward referral to specialist care. Primary physiotherapy management should include education, exercise and activity advice. The goal is to empower the patient to develop understanding of their condition and its unique biopsychosocial contributors, and to develop confidence to self-manage via load modification and exercise strategies. The success of this approach is reliant on an effective alliance between the health professional and patient with Achilles tendinopathy, which enables shared decisions about treatment and goals, as well as understanding individual barriers and enablers.[82]

Although they are not all evidence-based, some relatively safe and accessible physiotherapy adjuncts to help pain include advice about ice or heat, rigid taping to reduce ankle range of motion (eg, augmented low dye tape), heel wedges (0.8 to 1.2 cm generally based on comfort), and advice to wear shoes with a pitch of > 8 mm and avoid walking barefoot or with flat shoes. Heel wedges, appropriate shoes and avoiding stretching also reduce compression loads for people with insertional Achilles tendinopathy. Consideration may also be given to advice about non-steroidal anti-inflammatories (for sudden onset or new symptoms) or pain medication (longer term presentations). Other physiotherapy adjuncts targeting biopsychosocial factors may involve a multidisciplinary team (such as dietetics and exercise physiology input to manage weight or psychology to manage severe mood issues) (Figure 4). Knowledge of prognostic factors is incomplete but they may include obesity, body mass index and psychological factors,[83,84] which may be addressed with primary treatments and some of the outlined adjuncts. Some patients may not want to undertake exercise, or exercise may not be an option due to some other condition (eg, severe forefoot pain limiting calf raise exercise); in these instances, it is helpful for healthcare professionals to have alternative evidence-based treatments that may be offered (Figure 4).

Where low adherence to recommendations is a potential reason for inadequate response, a shared decision to extend the primary

Table 2a
Evidence summary for midportion Achilles tendinopathy: exercise, adjunct and education interventions.

Categories of interventions compared	Specific interventions compared	Short term (≤ 8 weeks)	Medium term (> 8 to 16 weeks)	Longer term (> 16 weeks)
Education/advice versus other education/ advice	Pain science versus other education	Neutral Pain/disability, pain and global change	Neutral Pain/disability and global change	
	Advice to continue or stop Achilles loads	Neutral Pain/disability and pain	Neutral Pain/disability and pain	Neutral Pain/disability and pain
Exercise versus control	Exercise versus wait-and-see		Favours exercise **Pain/disability**, pain, global change	
			Favours exercise Disability (social activities and running)	
			Neutral Disability (home, recreation, other activities)	
Exercise versus other exercises	Eccentric versus alternative exercise		Favours alternative Global change	Favours alternative Global change
		Neutral Pain/disability	Favours alternative[a] Pain/disability	Neutral Pain/disability
		Favours alternative Pain	Neutral Pain	Neutral Pain
	Eccentric versus concentric exercise	Favours eccentric Pain	Favours eccentric **Global change**	
	Eccentric versus stretching		Neutral[b] Global change	Neutral[b] Global change
	Eccentric versus eccentric + isometric	Neutral Pain/disability, global	Neutral Pain/disability, global	
Exercise + adjunct versus exercise	Adding radial ESWT to exercise		Favours ESWT Pain/disability, pain, global change	
	Adding radial ESWT or placebo to exercise	Favours intervention **Pain/disability, pain**		Favours intervention **Pain/disability, pain**
	Adding radial/focused or placebo ESWT to exercise	Neutral Pain	Favours ESWT Pain	
	Adding focused ESWT or placebo to exercise	Neutral[b] Pain, global change		Neutral[b] Pain, global change
	Adding night splint to exercise	Neutral Pain, disability	Neutral Pain, disability, pain/disability, global	Neutral Pain, disability, pain/disability, global
	Adding orthotics or placebo to exercise	Neutral Global change	Neutral Global change	Neutral Global change
		Neutral Pain/disability	Neutral Pain/disability	Neutral Pain/disability
	Adding AirHeel to exercise		Neutral Disability	
			Favours AirHeel Pain[c]	
		Neutral Pain	Neutral Pain[d]	
	Adding pressure massage to exercise	Neutral Pain/disability	Neutral Pain/disability	Neutral Pain/disability
	Adding LLLT or placebo to exercise	Neutral Pain/disability, pain	Neutral Pain/disability, pain	Neutral Pain/disability, pain
	Adding needling + stimulation or placebo to exercise	Neutral Pain/disability, global change	Neutral Pain/disability, global change	Neutral Pain/disability, global change
	Adding dry needling to exercise	Neutral Pain	Neutral Pain	

Table 2a (*Continued*)

Categories of interventions compared	Specific interventions compared	Short term (≤ 8 weeks)	Medium term (> 8 to 16 weeks)	Longer term (> 16 weeks)
Exercise versus adjuncts[e]	Eccentric versus acupuncture	Favours acupuncture **Pain/disability**	Favours acupuncture **Pain/disability**	Favours acupuncture Pain/disability
	Eccentric versus traditional care[f]	Favours eccentric Pain/disability	Favours eccentric **Pain/disability**	
	Eccentric versus heel wedge	Favours heel wedge Pain/disability	Favours heel wedge Pain/disability	
		Favours heel wedge Pain	Favours heel wedge Pain	
		Neutral Global	Favours heel wedge Global	
	Eccentric versus night splint	Neutral Disability, pain	Neutral Disability, pain	Neutral Disability, pain
	Eccentric versus ESWT		Neutral Pain/disability, pain	
			Neutral Global	
	Eccentric versus AirHeel	Neutral Pain	Neutral Pain	
	Eccentric versus US	Neutral Pain	Neutral Pain	
	Eccentric versus pressure massage	Neutral Pain/disability	Neutral Pain/disability	Neutral Pain/disability
Adjunct versus control	Radial ESWT versus wait-and-see		Favours ESWT Pain/disability, pain	
			Neutral Global change	
	Focused ESWT versus placebo		Neutral[b] Pain	
	LLLT versus placebo	Neutral Pain/disability, pain	Neutral Pain/disability, pain	
	Acupuncture versus placebo	Neutral Pain/disability, pain	Neutral Pain/disability, pain	

Evidence certainty is based on GRADE. Clinically meaningful benefits are bolded.
ESWT = extracorporeal shock wave therapy, LLLT = low-level laser therapy, US = ultrasound.
[a] Stasinopoulos 2013[96] removed in sensitivity analysis.
[b] Mixed cohort of insertional and midportion Achilles tendinopathy.
[c] Unspecified pain from Knobloch 2008[114] (see Appendices 3 and 4).
[d] Foot and Ankle Outcome Score (FAOS) pain from Knobloch 2008[114] (see Appendices 3 and 4).
[e] Some exercise arms contained the adjuncts tested in the comparator. However, the fundamental question was still the same: How do adjuncts alone compare with exercise (± adjuncts)?
[f] Deep friction massage and therapeutic US was 'traditional' in both studies and Herrington et al 2007[116] also included these adjuncts in the exercise arm.

Moderate certainty evidence of a between-group difference.
Low certainty evidence of a between-group difference.
Very low certainty evidence of a between-group difference.
Moderate certainty evidence favouring neither intervention.
Low certainty evidence favouring neither intervention.
Very low certainty evidence favouring neither intervention.

management period may be reached. Otherwise, secondary management can be initiated (Figure 4); this involves medical referral for consideration of imaging and specialist care (usually a sports or musculoskeletal physician), with or without a repeat of the primary treatments. Although uncommon, people who suffer continued impairments may consider surgery.

It is beyond the scope of this review to evaluate the evidence about all management options for Achilles tendinopathy. The following sections discuss the evidence for primary physiotherapy interventions versus important comparators, including: education or advice versus control or other education or advice; exercise versus control or other exercise; exercise plus an adjunct versus exercise or exercise versus an adjunct; and adjunct versus control. See the eAddenda for between-group effects and Grading of Recommendations Assessment, Development and Evaluation (GRADE) assessment (Appendix 1), PEDro scores (Appendix 2) and forest plots of pooled data and GRADE assessment (Appendices 3 and 4). An outline of the search, trial selection, quality appraisal and data pooling methods is provided in Appendix 4. Forty-four trials addressing the comparisons of interest were identified and the PEDro scores ranged from 3 to 10. Tables 2a and 2b provide an evidence summary about education, exercise and adjunct interventions for Achilles tendinopathy.

Education and advice

Developing an individual's understanding of their health condition facilitates shared decision-making and successful self-management. Education (imparting knowledge) and advice (counsel regarding action the patient can take in management) for Achilles tendinopathy is guided by themes arising from qualitative studies[26-29] and clinical practice guidelines[53] in this population. People affected by this condition express a desire to understand

Table 2b
Evidence summary for insertional Achilles tendinopathy: exercise and adjunct interventions.

Categories of interventions compared	Specific interventions compared	Short term (≤ 8 weeks)	Medium term (> 8 to 16 weeks)	Longer term (> 16 weeks)
Exercise + adjunct versus exercise	Adding instrumented manual therapy to exercise	Neutral Pain/disability	Favours instrumented **Pain/disability**	Favours instrumented Pain/disability
		Neutral Pain	Neutral Pain	Neutral Pain
			Neutral Global	
	Adding ESWT or placebo to exercise	Neutral Pain/disability	Neutral Pain/disability	Neutral Pain/disability
		Neutral Pain	Netural Pain	Neutral Pain
Exercise versus adjunct	Eccentric versus ESWT		Favours ESWT Pain/disability, pain, global	
	Eccentric exercise versus multimodal[a]		Neutral Pain	

Evidence certainty is based on GRADE. Clinically meaningful benefits are bolded.
ESWT = extracorporeal shock wave therapy.
[a] Stretch, massage, bilateral heel lifts, night splint included as 'multimodal' in both groups.

Low certainty evidence of a between-group difference.
Very low certainty evidence of a between-group difference.
High certainty evidence favouring neither intervention.
Moderate certainty evidence favouring neither intervention.
Low certainty evidence favouring neither intervention.
Very low certainty evidence favouring neither intervention.

causes, what the pathology is, expected outcomes and what is needed to overcome the condition. They also express: fears about making their condition worse or a tendon rupture; maladaptive beliefs (eg, rest is needed to overcome their pain); and a desire for individualised care and support. Suggested education and advice topics and strategies to improve engagement are shown in Figure 5. 'Education beyond words'[29] is important and can be achieved with the use of engaging and patient-friendly demonstration of data that challenge beliefs, and multimedia resources (websites, videos) (examples provided in Figure 5). Education and advice recommendations should be tailored to individual needs identified during assessment.

Two trials[9,85] have specifically investigated education or advice versus other education or advice for Achilles tendinopathy (Appendix 1). Chimenti et al[85] compared pain science education (focusing on neurophysiology of pain and addressing fear of movement) with control education (focusing on pathophysiology and pathoanatomy). There was low certainty of evidence that these two interventions did not substantially differ in their effects on pain (short term), composite pain and disability, or global change outcomes at short and medium

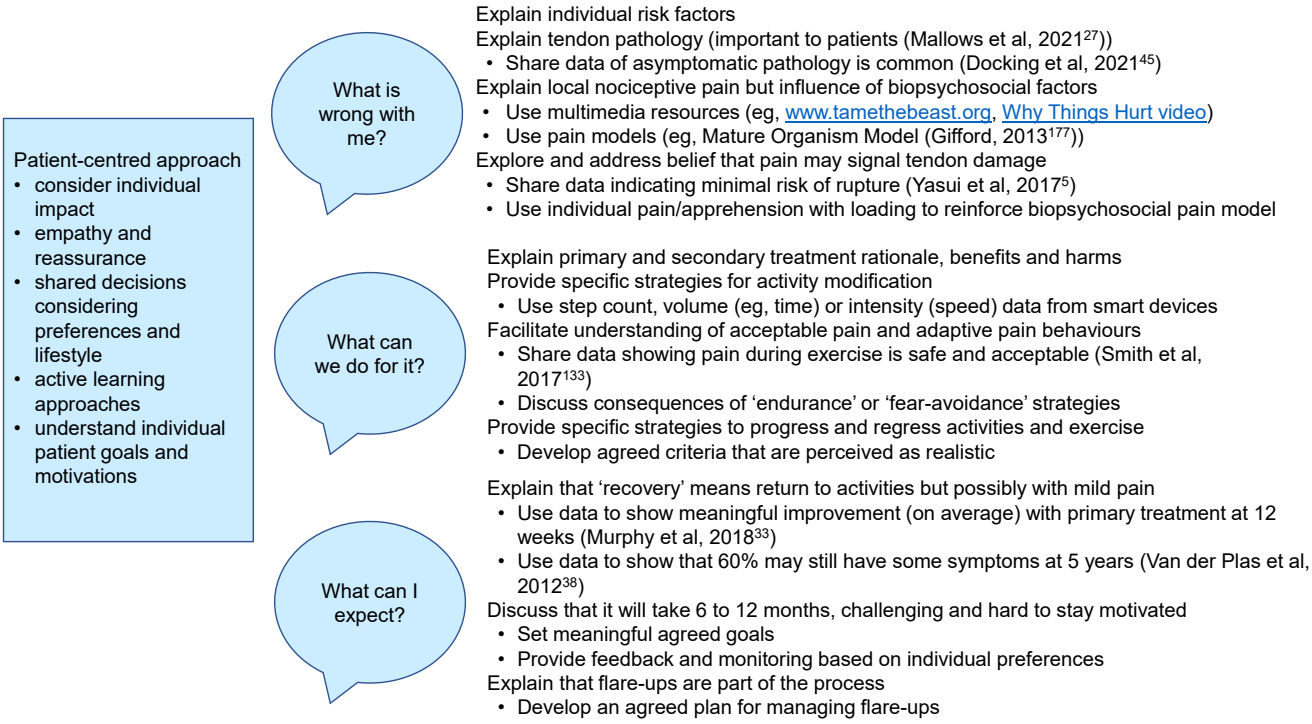

Figure 5. Education strategies for Achilles tendinopathy.

term (Table 2a). Both groups experienced improved self-efficacy and reduced fear of movement, which may be explained by education about acceptable pain with exercise and activity delivered to both groups, which is likely to be very important to allay movement-related fears.[86] Silbernagel et al investigated exercise with the addition of either continued sport activity (if pain during activity was acceptable) or forced cessation of sport activity for 6 weeks (regardless of pain). There was low certainty of evidence for no between-group differences for composite pain and disability or pain outcomes at all timepoints (Table 2a) but evidence of worse physical function at 12 months (relative harm) in the group that was forced to stop sport. Clinical practice guidelines, therefore, recommend continued activity within acceptable pain limits rather than forced rest from activity.[53]

In practice, activity modification is the most effective strategy to manage pain and therefore critical to the success of physiotherapy management. Removing provocative (ascertained from the history) and higher-intensity stretch-shorten cycle activities (faster running or walking or hills) and reducing volume by $\geq$ 50% is often necessary for a period of 2 to 6 weeks when load tolerance is severely compromised (Figure 2). It is important to appreciate that although uncommon, people with very high pain levels may benefit from ceasing provocative activity (100% reduction) in the short term (eg, stopping sport or wearing a boot if walking is the provocative activity). Explaining the rationale for activity modification, especially for people who adopt an 'activity endurance strategy' despite pain,[69] will facilitate setting shared and effective activity goals. People who adopt the opposing coping strategy (ie, activity avoidance,[69] often driven by fear that activity will make their condition worse[28,29]) will benefit from gradual activity exposure coupled with acceptable pain education and strategies to monitor pain and activity (Figure 6).

Behaviour change strategies should be considered to optimise implementation of self-management exercise and activity modification strategies, including: addressing beliefs and outcome expectations; setting shared goals that are meaningful to the patient (which requires understanding their motivations to achieve these goals); action intention strategies, feedback and monitoring dependent on individual needs and preferences; and practical strategies to improve exercise self-efficacy (eg, providing videos of exercises).[87]

Exercise

Thirty-nine trials (40 reports)[32,88-125] were identified that investigated exercise (versus control, other exercise or adjuncts) for Achilles tendinopathy. However, most trials were underpowered and included diverse interventions and outcomes, which limits data pooling (see Appendix 4); these issues limit the certainty of conclusions. The most common exercise programs were the Afredson eccentric program (or modified versions), the Silbernagel program, the Stanish and Curwin program and the heavy slow resistance program, as described in Table 3.

Is exercise superior to wait-and-see or placebo?

No studies compared exercise to placebo, and only two trials[32,90] compared the eccentric program with a wait-and-see approach (Table 2a, Appendix 1). There was low to very low certainty of evidence for benefit favouring exercise at the medium term (clinically important for pain/disability). A recent network meta-analysis found that most of the treatments being assessed (ie, exercise alone or combined with extracorporeal shockwave therapy [ESWT] or

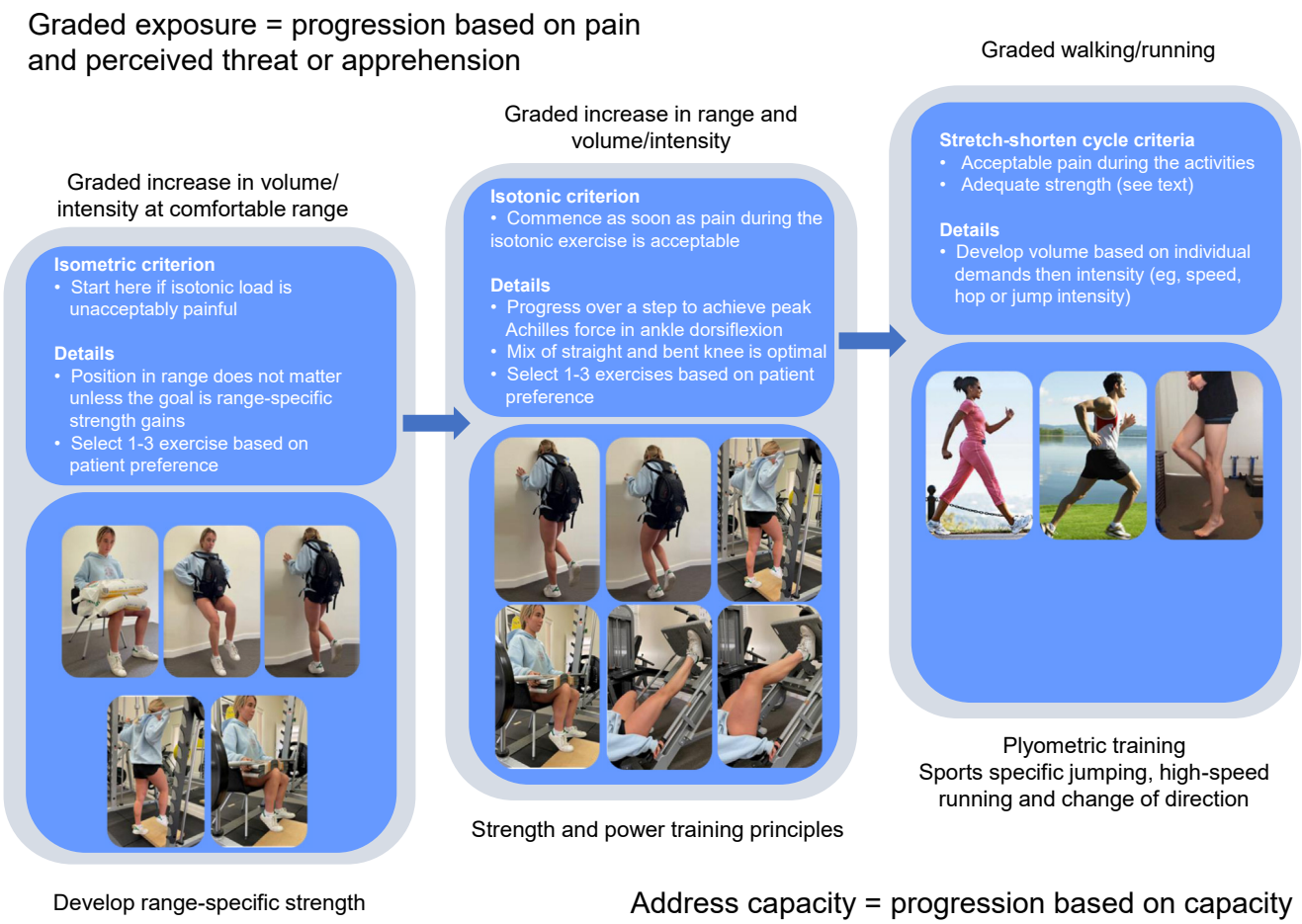

Figure 6. Graded exposure and addressing capacity exercise approaches in Achilles tendinopathy.

Table 3
Characteristics of common exercise interventions for Achilles tendinopathy.

Characteristic	Exercise intervention					Comment
	Stanish and Curwin[174,175]	Alfredson[176]	Modified Alfredson[32,97,98,103,119,124,125]	Silbernagel[9]	Heavy slow resistance (HSR)[91]	
Frequency	1/d	1/d	1 to 2/d	1/d	3/wk	• 2/d to 3/wk
Intensity	Not specified	Not specified	Not specified	Goal of 15 reps but intensity target (eg, fatigue, RPE, reps in reserve) not clearly stated	15RM wk 1 12RM wk 2 to 3 10RM wk 4 to 5 8RM wk 6 to 8 6RM wk 9 to 12	• One (20%) program sets intensity targets • HSR is the most intense program
Sets Reps	5 10 to 20	3 15	3 15	3 $\leq$ 15	3 to 4 15 to 6	• Reps/wk = 107 (average for HSR) to 1,260 (Alfredson)
Duration *(wk)*	12	12	12	12 to 26	12	• One (20%) program is > 12 wks
Tempo	Fast eccentric phase	Not specified	Not specified	Faster calf raise is a progression	3 s/phase (6 s total)	• Two (40%) programs add speed
Rest	Not specified	Not specified	Not specified	Not specified	2 to 3 min between sets, 5 min between exercises	• One (20%) program describes rest time
Exercise and contraction type	1. Warm-up 2. Static stretch 3. Concentric-eccentric single leg, standing calf raise exercise 4. Static stretching 5. Ice application	Isolated eccentric standing calf raise, single leg, knee bent and knee straight	Isolated eccentric, standing calf raise single leg, knee bent and knee straight	1. Concentric-eccentric double leg standing calf raise 2. Single leg 3. Isolated eccentric 4. Faster calf raises 5. Plyometric training	Concentric eccentric, double leg gym exercises (seated calf raise, standing calf raise, calf raise in a leg press machine)	• Most (60%) use concentric-eccentric combined • Silbernagel is the most varied, although 'plyometric' not described
Progression	Speed then load	Load	Load	1. Increasing range of motion 2. Over a step 3. Increasing repetitions 4. Adding load	Load	• Silbernagel is the most progressive
Progression rules and tailoring	Add speed then load to achieve pain target	Add load to achieve pain target	Increasing sets or reps as tolerated[97,103,125] or based on time[32,119,124] or 1 x/d[98]	Intensity and number of reps based on patient status	Time-based intensity progression	• Silbernagel and modified Alfredson are the most flexible
Pain	Enough load to be painful in the third set	Enough load to achieve up to moderate pain	Enough load to achieve up to moderate pain	Pain is not a goal but acceptable	Pain is not a goal but acceptable	• 60% of programs try to achieve some pain
Setting	Home-based	Home-based	Home-based	Home-based	Gym-based	• 80% of programs are home-based
Activity advice	Not specified	Allowed if can be performed with mild symptoms	Allowed if can be performed with mild symptoms	Allowed if can be performed with mild symptoms	No sport for first 3 wks then allowed if can be performed with mild symptoms	• Most programs (60%) allow sport if symptoms are mild

HSR = heavy slow resistance, Reps = repetitions, RPE = Rating of perceived exertion.

supplements, ESWT, acupuncture) were superior to wait-and-see at 12 weeks.[126]

Is there an exercise approach that can be recommended based on the evidence?

Nine trials[91-99] compared different exercise programs among people with Achilles tendinopathy (Table 2a and Appendix 1). A version of the Alfredson program was used in each of these trials. There was evidence (moderate certainty at longer term and very low certainty at medium term) for global change benefit of Silbernagel or heavy slow resistance programs over Alfredson. There was also conflicting benefit of other outcomes (only at medium term for pain/disability and short term for pain) favouring alternative programs (heterogeneous programs but all involved lower volume than Alfredson, which may be more convenient) over the Alfredson program Murphy et al[58] reported a similar outcome in a recent meta-analysis. There were very low certainty benefits for eccentric over concentric exercise at short (pain) and medium term (global change, which was also clinically important). However, the trial[94] reporting benefit at medium term investigated a very low volume and intensity concentric exercise program compared with a very high volume and intensity eccentric exercise program, so it is unclear which variable(s) may explain the benefit. Clinicians should consider the modified Alfredson, Silbernagel and heavy slow resistance programs as alternatives to the Alfredson program. Given that they are heterogeneous (Table 3), clinicians should adopt an individualised and patient-centred approach to exercise prescription, with consideration of patient preferences (eg, for exercise frequency or support) and motivation, as well as resources (eg, time and equipment).

Implications from the exercise literature regarding exercise mechanisms

The biomedical view is that exercise for Achilles tendinopathy (and tendinopathy more generally) improves outcomes (such as pain, disability and function) via local (muscle-tendon) mechanical mechanisms.[127] Potential mechanisms include disrupting pain-producing neurovascular ingrowth into the tendon[128] or stimulating tendon healing via collagen synthesis.[129] Development of exercise strength (eg, neuromuscular activation or hypertrophy) may improve disability and function, although pathways linking strength with improved pain are less clear.[130] Local mechanical mechanisms need to be questioned because exercise does not appear to consistently influence markers of neurovascular ingrowth,[131] tendon healing observed with imaging[132] or muscular strength,[61] despite improvements in self-reported pain, disability and other outcomes. Comparable benefits from vastly different exercise approaches observed in this review and others suggest that other mechanisms such as improved self-efficacy or reduced movement-related fear may mediate exercise outcomes. In a recent meta-analysis, Smith et al[133] found low certainty evidence that pain outcomes may be improved in the short and medium term with painful rather than pain-free exercises. Advising painful exercise normalises pain that patients with Achilles tendinopathy typically experience with exercise and may positively impact on movement-related fear.[86]

Suggested exercise approaches based on the existing literature

Graded exposure in Achilles tendinopathy rehabilitation

Given this proposed view of exercise mechanisms, exercise for Achilles tendinopathy can be re-conceptualised as 'graded exposure'. The goal is to expose the person to activities that are 'graded' based on perceived threat and apprehension (useful for those with kinesiophobia and fear-avoidance) but also based on patient-reported level of pain (Figure 6).[134] Progression generally involves increasing difficult of exercise (eg, adding external load; introducing low and then high intensity stretch-shorten cycle), which provides an opportunity to reconceptualise pain and threat value.[130]

Phase one involves isometric exercise, which may be a necessary starting point for patients with unacceptable symptoms during isotonic exercise. This is because a point in range can usually be found where symptoms are tolerable. Although early evidence suggested that isometric may also achieve superior immediate pain reduction compared with isotonic loading, these findings have been challenged.[135] *Phase two*, involving isotonic (in terms of external load not muscle-tendon unit load) exercise should be the starting point if tolerable; otherwise, the goal should be to progress to this phase as soon as possible. Exercise in this phase is generally performed slowly (using a metronome can help to ensure it is slow with good technique - set metronome at 60 bpm and aim for 2 to 3 seconds for each of the concentric and eccentric phases) through full range of motion to ensure that tolerance and confidence is achieved through range. Progressing as tolerated to full ankle dorsiflexion range of motion is important, as this is where greatest Achilles tendon loads occur[136] (see caveat below for insertional Achilles tendinopathy). Programs such as the modified Alfredson, Silbernagel and heavy slow resistance (which involve exercise between 3x/week and daily) are recommended (based on pooled data above) (Table 3). *Phase three* involves graded introduction of stretch-shorten cycles such as walking and running activities based on agreed goals (generally two to three times per week with rest days in between). This phase involves higher tendon loads and risk of pain flare than prior phases, so careful monitoring of load tolerance is needed (Figure 2). To ensure it is gradual, introduction of running or walking loads should be guided by objective data such as running time and intensity (eg, pace) and step count data, respectively.

How long an individual takes to progress through each phase is highly variable and depends on their load tolerance and progression (eg, if load tolerant, some patients may progress to restoration of stretch-shorten cycle loads even in the first session). The isotonic and stretch-shorten cycle phases are generally performed two to three times per week each. Ideally, stretch-shorten cycle exercise is performed prior to (eg, in the morning of) isotonic exercise to enable complete rest days (only possible with isotonic programs that are performed 3 times per week), or an alternative is performing stretch-shorten cycle exercise on the days off from isotonic loads.

Addressing specific capacity

Despite improved pain following rehabilitation, some patients with Achilles tendinopathy have persisting calf strength and power capacity impairments.[137] This is important because calf strength impairment is a risk factor for onset of Achilles tendinopathy[138] and may be related to recurrence. The calf needs to contract strongly to enable the tendon to store and release energy during stretch-shorten cycle activities.[13] Tendon energy storage and release in turn reduces energy cost of locomotion and enables greater power production.[13] Therefore, specific considerations for recovering calf strength and power may assist some patients to regain optimal function.

Suggestions for how the graded exposure phases can be adapted to consider capacity are provided in Figure 6. In the isotonic phase, progression to higher intensity exercise (as in the heavy slow resistance program), including lower repetition ranges, can target maximal strength, and adding speed (or intent to move quickly) can address rate of force development.[139] Eccentric overload training (performed with a load that cannot be shifted concentrically) can be considered to maximise mechanical stimulus, tissue adaptation potential, and neural adaptations from resistance training.[140,141] Per-session training intensity can be monitored and adjusted using repetitions in reserve or exercise intensity scales (eg, OMNI scale).[142] It is important to train both sides individually (good principle for all isometric and isotonic loading unless the individual can only manage bilateral exercise). Often the load lifted can be higher on the unaffected side to achieve the same intensity target. Inclusion of straight and bent-knee options will ensure adequate focus on soleus (Figure 6). Load can be added using a backpack containing weights in standing or with 20 kg sandbags (accessible at hardware stores) in seated (although the practical limit seems to be 60 kg [3 × 20 kg sandbags] with this option, so it is only useful for patients with

poorer strength). Utilising gym machines (based on patient preference and access) such as the Smith, standing or seated calf raise machines can enable higher load intensity progression.

A consideration related to higher intensity exercise is tendon adaptation. Healthy tendon adapts (becomes more load resistant, eg, increased stiffness) with high-intensity exercise (> 70% maximal voluntary contraction (MVC), equating to 4.5 to 6.5% strain) regardless of contraction type (isometric or isotonic).[127] It is unknown how this translates to pathological tendons. Regardless, ensuring that at least one exercise achieves a high intensity may increase the chance of tendon adaptation, assuming that this is possible for pathological tendon.[127] Issues with this approach are that there are no reliable means of assessing MVC in a clinical setting and tendon strain for this MVC level varies between individuals.[127] A pragmatic clinical approach is to utilise an OMNI scale rating of 8 to 9 out of 10,[143] based on individual comfort.

In the stretch-shorten cycle phase, reactive strength capabilities can be developed via progressive plyometric interventions (landing, jumping and hopping; see here for an example for recreational runners[144]). Depending on individual goals, development of sports-specific high-speed running and change of direction competencies can also be considered. Given that adequate strength is required for power, muscle strength targets should be considered prior to power progression. For example, achieving (or approaching) 1.5 times body weight 6RM in seated calf raise (or 0.5 times body weight in standing) is desirable for recreational runners prior to running and submaximal hopping.[74] Adequate maximal strength should be the goal prior to commencing maximal plyometric or high-speed running progressions.

A common capacity impairment is inability to perform a single leg calf raise (at all or with adequate height), which indicates that standing calf raise 1RM is lower than the individual's body weight. This is a challenging impairment that requires a specific exercise strategy. One option is to start with double leg concentric-eccentric loading. Utilising bathroom scales under each leg can ensure that the unaffected leg is not being favoured and the goal is to eventually move towards 60 to 100% body weight on the affected side (ensuring adequate planterflexor height prior to progression). Another option that enables more specific and measurable load application is performing a seated single-leg calf raise with a gradually increasing proportion of body weight based on individual capacity. These options can be supplemented by performing isometrics near full plantarflexion to achieve strength gains specific to this part of the range[145] or performing eccentric-only exercise, which may be possible (when concentric-eccentric is not) given it utilises fewer active motor units than concentric contraction when external load and speed are constant.[146] Progression to concentric is required, as strength adaptation may be specific to contraction type.[146]

Adjuncts

Evidence for adjuncts added to primary treatment

Eighteen trials (19 reports)[98,100-115,119,124] investigated whether various adjuncts improved outcomes when added to exercise (Table 2a, Appendix 1). There was low certainty evidence that, when added to exercise, radial ESWT may improve pain/disability and pain outcomes at all time points and global change at medium term (Table 2a). Importantly, the benefits were still present even when a placebo comparator was used (used in one[112] of the two studies[108]). In contrast, there was very low certainty evidence for conflicting or no benefit when adding focused or combined radial/focused ESWT compared with a placebo (pain and global change across various timepoints, Table 2a). Current evidence favours the addition of radial over other forms of ESWT but, given the low certainty of evidence, large trials comparing this modality to placebo are needed. There was low to very low certainty evidence that the addition of other adjuncts to exercise (including low-level laser therapy [LLLT], AirHeel brace, night splint, needling, pressure massage and custom orthotics) did not add benefit (Table 2a).

Evidence for adjuncts as an alternative to primary treatment

Thirteen trials[32,88,105,116-125] investigated exercise versus adjuncts and a further four investigated an adjunct versus control[32,147-149] (Table 2a, Appendix 1). Although limited, there is some evidence for standalone alternatives to exercise care. There was low certainty evidence that acupuncture may be superior to exercise for pain/disability across all timepoints (clinically meaningful in the short and medium term). The only other positive evidence was for heel wedges, for which there was very low certainty evidence for benefit over exercise for pain/disability, pain and global change outcomes in the medium term, yet conflicting benefit in the short term. Very low certainty evidence suggested that traditional physiotherapy including frictions and ultrasound (pain/disability at short and medium term) may be less beneficial than exercise, so is an unsuitable alternative treatment. There was low to very low certainty evidence for no difference (for a majority of comparisons) between other adjuncts (ESWT, night splint, AirHeel brace, pressure massage, ultrasound) and exercise for various timepoints and outcomes (Table 2a). Although within-group benefits over time for these adjuncts are generally clinically important, the estimates of the between-group difference often have a lot of inherent uncertainty so the interventions should not be considered equivalent without careful consideration of the confidence interval around the between-group difference. Given that exercise is a more established treatment (with benefits over wait-and-see), the best alternative options are those with some evidence of superiority over exercise.

Comparisons between adjuncts and placebo showed that LLLT and acupuncture may not show benefit (very low certainty evidence for pain/disability in the short and medium term) (Table 2a). The acupuncture finding cautions against overenthusiasm in relation to the acupuncture benefit over exercise derived from a single study (described above). There was low certainty evidence for benefit of radial ESWT compared with wait-and-see (for two out of three outcomes, Table 2) but no benefit of focused ESWT versus placebo. Given the differences in the type of ESWT and comparator it is difficult to explain these findings.

Insertional Achilles tendinopathy

There is much less evidence specifically related to insertional Achilles tendinopathy, including no trials comparing exercise with control or different exercise programs. Three trials[103,110,111] investigated the addition of adjuncts to exercise, and two[117,118] compared adjuncts with exercise (Table 2b, Appendix 1). There was low certainty evidence for benefit when adding instrumented manual therapy to exercise for pain/disability at medium and longer term (clinically important for medium term), but not for pain/disability at short term, global change at medium term or pain at any timepoint. There was high certainty of evidence (pain) and moderate certainty evidence (pain/disability) of no worthwhile benefit from adding ESWT to exercise, but low certainty evidence that ESWT alone was more effective than exercise (range of outcomes at medium term, Table 2b). Interestingly, these data contrast with midportion Achilles tendinopathy, where the addition of ESWT to exercise may be warranted but not as a standalone treatment. A possible explanation is poorer exercise outcomes, which have been reported for insertional Achilles tendinopathy.[150] There was very low certainty evidence for no difference between stretch, massage, bilateral heel lifts, night splint with or without Alfredson eccentric exercise over a step (pain at medium term). This may be because Alfredson eccentrics into full range of dorsiflexion, stretching and night splints may increase insertional tendon compression and provoke symptoms.

Despite the lack of specific evidence, the management principles outlined in this review apply to insertional Achilles tendinopathy. Based on case series evidence of poor outcomes with a traditional Alfredson eccentric training (exercise over a step into ankle dorsiflexion),[150] there are suggestions to limit ankle dorsiflexion (and thereby compression) in insertional Achilles tendinopathy.[151] Care is needed, as complete avoidance of ankle dorsiflexion may have a nocebo effect (prolonging recovery)[152] and may reduce outcomes,

Figure 7. Progression of ankle dorsiflexion during calf raise exercise for insertional Achilles tendinopathy.

given that tendon force is greatest in ankle dorsiflexion.[136] Advice in the isotonic phase should be to limit ankle dorsiflexion if it is painful but to aim for graded introduction of dorsiflexion as symptoms allow. Custom-made small steps of increasing size (10 mm, 20 mm, 30 mm, Figure 7) can be used to progress dorsiflexion range based on tolerance (avoiding extreme end range, so not everyone will progress to 20 mm or 30 mm).

Current research trends and future directions

More Achilles tendinopathy research is being published than ever before (28 of the 44 trials identified in this review were published within the last decade); however, these efforts are not translating to improved knowledge and patient benefit. Most studies were underpowered and focused on the use of adjunct interventions (32 of 41, 78%) rather than different exercise types or education and advice interventions. They investigated heterogeneous outcomes, which hampered pooling in meta-analyses. Large, adequately powered trials are needed to improve knowledge of primary physiotherapy interventions (education, advice and exercise) for insertional particularly but also midportion Achilles tendinopathy. This should include investigation of the benefit of education as a standalone treatment and new exercise approaches (eg, stretch-shorten cycle loading for certain athletic groups and use of technology to monitor and improve exercise adherence and fidelity). International consensus efforts are currently underway to raise standards of Achilles tendinopathy research (eg, developing a core outcome set[153] and consensus on diagnosis) as well as addressing unmet needs (eg, developing stakeholder informed education for this condition). Despite the recognition of biopsychosocial aspects of Achilles tendinopathy, basic biological knowledge is still lacking and an exciting new area of enquiry is focusing on subtendon (from the muscle components of the calf) function and implications for pathology and treatment (eg, the study by Yin et al[154]). Understanding how biopsychosocial factors influence risk, impairments and treatment outcomes will be critical to drive development of new patient-centred and more effective treatments.

eAddenda: Appendices 1, 2, 3 and 4 can be found online at https://doi.org/10.1016/j.jphys.2022.09.010

Ethics approval: Not applicable.

Competing interests: Nil.

Source(s) of support: Nil.

Acknowledgements: Sincere thanks to Sanam Tavakkoli Oskouei who assisted with data quality appraisal, risk of bias assessment, data extraction and pooling and data checking.

Provenance: Invited. Peer reviewed.

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References

1. Scott A, Squier K, Alfredson H, Bahr R, Cook JL, Coombes B, et al. Icon 2019: international scientific tendinopathy symposium consensus: clinical terminology. *Brit J Sports Med*. 2020;54:260–262.
2. Lopes AD, Hespanhol LC, Yeung SS, Costa LOP. What are the main running-related musculoskeletal injuries? *Sports Med*. 2012;42:891–905.
3. Kujala UM, Sarna S, Kaprio J. Cumulative incidence of achilles tendon rupture and tendinopathy in male former elite athletes. *Clin J Sport Med*. 2005;15:133–135.
4. de Jonge S, Van den Berg C, de Vos R-J, Van Der Heide HJ, Weir A, Verhaar JA, et al. Incidence of midportion Achilles tendinopathy in the general population. *Brit J Sports Med*. 2011;45:1026–1028.
5. Yasui Y, Tonogai I, Rosenbaum AJ, Shimozono Y, Kawano H, Kennedy JG. The risk of Achilles tendon rupture in the patients with Achilles tendinopathy: healthcare database analysis in the United States. *BioMed Res Int*. 2017;2017.
6. Chimenti RL, Cychosz CC, Hall MM, Phisitkul P. Current concepts review update: insertional Achilles tendinopathy. *Foot Ank Int*. 2017;38:1160–1169.
7. Kvist M. Achilles tendon injuries in athletes. 1991:188–201.
8. Fahlström M, Lorentzon R, Alfredson H. Painful conditions in the Achilles tendon region in elite badminton players. *Am J Sports Med*. 2002;30:51–54.
9. Silbernagel KG, Thomeé R, Eriksson BI, Karlsson J. Continued sports activity, using a pain-monitoring model, during rehabilitation in patients with Achilles tendinopathy: a randomized controlled study. *Am J Sports Med*. 2007;35:897–906.
10. Grävare Silbernagel K, Crossley KM. A proposed return-to-sport program for patients with midportion Achilles tendinopathy: rationale and implementation. *J Orthop Sports Phys Ther*. 2015;45:876–886.
11. Lichtwark GA, Wilson A. Interactions between the human gastrocnemius muscle and the Achilles tendon during incline, level and decline locomotion. *J Exp Biol*. 2006;209:4379–4388.
12. Komi PV. Stretch-shortening cycle: a powerful model to study normal and fatigued muscle. *J Biomech*. 2000;33:1197–1206.
13. Roberts TJ, Konow N. How tendons buffer energy dissipation by muscle. *Ex Sport Sci Rev*. 2013;41:4.
14. Willy RW, Halsey L, Hayek A, Johnson H, Willson JD. Patellofemoral joint and Achilles tendon loads during overground and treadmill running. *J Orthop Sports Phys Ther*. 2016;46:664–672.
15. Almonroeder T, Willson JD, Kernozek TW. The effect of foot strike pattern on Achilles tendon load during running. *Ann Biomech Eng*. 2013;41:1758–1766.
16. Clement D, Taunton J, Smart G. Achilles tendinitis and peritendinitis: etiology and treatment. *Am J Sports Med*. 1984;12:179–184.
17. Järvinen TA, Kannus P, Maffulli N, Khan KM. Achilles tendon disorders: etiology and epidemiology. *Foot Ank Clin*. 2005;10:255–266.

18. Di Caprio F, Buda R, Mosca M, Giannini S. Foot and lower limb diseases in runners: assessment of risk factors. *J Sports Sci Med*. 2010;9:587.
19. Mersmann F, Bohm S, Schroll A, Boeth H, Duda G, Arampatzis A. Muscle and tendon adaptation in adolescent athletes: a longitudinal study. *Scand J Med Sci Sports*. 2017;27:75–82.
20. Kjær M, Magnusson P, Krogsgaard M, Møller JB, Olesen J, Heinemeier K, et al. Extracellular matrix adaptation of tendon and skeletal muscle to exercise. *J Anat*. 2006;208:445–450.
21. Heinemeier K, Olesen J, Haddad F, Langberg H, Kjaer M, Baldwin KM, et al. Expression of collagen and related growth factors in rat tendon and skeletal muscle in response to specific contraction types. *J Physiol*. 2007;582:1303–1316.
22. Cook JL, Purdam C. Is compressive load a factor in the development of tendinopathy? *Brit J Sports Med*. 2012;46:163–168.
23. Malliaras P, O'Neill S. Potential risk factors leading to tendinopathy. *Apunts Medicina de l'Esport*. 2017;52:71–77.
24. Van Der Vlist AC, Breda SJ, Oei EH, Verhaar JA, de Vos R-J. Clinical risk factors for Achilles tendinopathy: a systematic review. *Brit J Sports Med*. 2019;53:1352–1361.
25. McAuliffe S, McCreesh K, Culloty F, Purtill H, O'Sullivan K. Can ultrasound imaging predict the development of Achilles and patellar tendinopathy? A systematic review and meta-analysis. *Brit J Sports Med*. 2016;50:516–1523.
26. Ceravolo ML, Gaida JE, Keegan RJ. Quality-of-life in Achilles tendinopathy: an exploratory study. *Clin J Sports Med*. 2020;30:495–502.
27. Mallows A, Head J, Goom T, Malliaras P, O'Neill S, Smith B. Patient perspectives on participation in exercise-based rehabilitation for Achilles tendinopathy: A qualitative study. *Musculoskelet Sci Pract*. 2021;56:102450.
28. Mc Auliffe S, Synott A, Casey H, Mc Creesh K, Purtill H, O'Sullivan K. Beyond the tendon: experiences and perceptions of people with persistent Achilles tendinopathy. *Musculoskelet Sci Pract*. 2017;29:108–114.
29. Turner J, Malliaras P, Goulis J, Mc Auliffe S. "It's disappointing and it's pretty frustrating, because it feels like it's something that will never go away." A qualitative study exploring individuals' beliefs and experiences of Achilles tendinopathy. *PloS one*. 2020;15:e0233459.
30. Visser TSS, Van Der Vlist AC, Van Oosterom RF, Van Veldhoven P, Verhaar JA, de Vos R-J. Impact of chronic Achilles tendinopathy on health-related quality of life, work performance, healthcare utilisation and costs. *BMJ Open Sport Exerc Med*. 2021;7:e001023.
31. Williams A, Kamper SJ, Wiggers JH, O'Brien KM, Lee H, Wolfenden L, et al. Musculoskeletal conditions may increase the risk of chronic disease: a systematic review and meta-analysis of cohort studies. *BMC Med*. 2018;16:1–9.
32. Rompe J, Nafe B, Furia J, 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;35:374–383.
33. Murphy M, Travers M, Gibson W, Chivers P, Debenham J, Docking S, et al. Rate of improvement of pain and function in mid-portion Achilles tendinopathy with loading protocols: a systematic review and longitudinal meta-analysis. *Sports Med*. 2018;48:1875–1891.
34. Sayana MK, Maffulli N. Eccentric calf muscle training in non-athletic patients with Achilles tendinopathy. *J Sci Med Sport*. 2007;10:52–58.
35. Ram R, Meeuwisse W, Patel C, Wiseman DA, Wiley JP. The limited effectiveness of a home-based eccentric training for treatment of Achilles tendinopathy. *Clin Invest Med*. 2013:E197–E206.
36. Lagas IF, Fokkema T, Bierma-Zeinstra SM, Verhaar JA, van Middelkoop M, de Vos RJ. How many runners with new-onset Achilles tendinopathy develop persisting symptoms? A large prospective cohort study. *Scand J Med Sci Sports*. 2020;30:1939–1948.
37. 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;39:607–613.
38. Van der Plas A, de Jonge S, de Vos R-J, Van Der Heide HJ, Verhaar JA, Weir A, et al. A 5-year follow-up study of Alfredson's heel-drop exercise programme in chronic midportion Achilles tendinopathy. *Brit J Sports Med*. 2012;46:214–218.
39. Lagas I, Tol J, Weir A. One in four patients with midportion achilles tendinopathy has persisting symptoms after 10 years: a prospective cohort study. *Am J Sports Med*. 2019.
40. Gajhede-Knudsen M, Ekstrand J, Magnusson H, Maffulli N. Recurrence of Achilles tendon injuries in elite male football players is more common after early return to play: an 11-year follow-up of the UEFA Champions League injury study. *Brit J Sports Med*. 2013;47:763–768.
41. Docking SI, Rio E, Cook J, Orchard JW, Fortington LV. The prevalence of Achilles and patellar tendon injuries in Australian football players beyond a time-loss definition. *Scand J Med Sci Sports*. 2018;28:2016–2022.
42. de Vos R-J, Van Der Vlist AC, Zwerver J, Meuffels DE, Smithuis F, Van Ingen R, et al. Dutch multidisciplinary guideline on Achilles tendinopathy. *Brit J Sports Med*. 2021;55:1125–1134.
43. Matthews W, Ellis R, Furness J, Hing WA. The clinical diagnosis of Achilles tendinopathy: a scoping review. *PeerJ*. 2021;9:e12166.
44. Rio EK, Mc Auliffe S, Kuipers I, Girdwood M, Alfredson H, Bahr R, et al. ICON PART-T 2019–International Scientific Tendinopathy Symposium Consensus: recommended standards for reporting participant characteristics in tendinopathy research (PART-T). *Brit J Sports Med*. 2020;54:627–630.
45. Docking SI, Hart HF, Rio E, Hannington MC, Cook JL, Culvenor AG. Explaining Variability in the Prevalence of Achilles Tendon Abnormalities: A Systematic Review With Meta-analysis of Imaging Studies in Asymptomatic Individuals. *J Orthop Sports Phys Ther*. 2021;51:232–252.
46. Hutchison A-M, Evans R, Bodger O, Pallister I, Topliss C, Williams P, et al. What is the best clinical test for Achilles tendinopathy? *Foot Ank Surg*. 2013;19:112–117.
47. Maffulli N, Kenward MG, Testa V, Capasso G, Regine R, King JB. Clinical diagnosis of Achilles tendinopathy with tendinosis. *Clin J Sport Med*. 2003;13:11–15.
48. Reiman M, Burgi C, Strube E, Prue K, Ray K, Elliott A, et al. The utility of clinical measures for the diagnosis of Achilles tendon injuries: a systematic review with meta-analysis. *J Athl Train*. 2014;49:820–829.
49. Vallance P, Hasani F, Crowley L, Malliaras P. Self-reported pain with single leg heel raise or single leg hop offer distinct information as measures of severity in men with midportion and insertional Achilles tendinopathy: an observational cross-sectional study. *Phys Ther Sport*. 2021;47:23–31.
50. Cook JL, Khan K, Kiss ZS, Purdam CR, Griffiths L. Reproducibility and clinical utility of tendon palpation to detect patellar tendinopathy in young basketball players. *Brit J Sports Med*. 2001;35:65–69.
51. Docking SI, Ooi CC, Connell D. Tendinopathy: is imaging telling us the entire story? *J Orthop Sports Phys Ther*. 2015;45:842–852.
52. Lewis JS, Cook CE, Hoffmann TC, O'Sullivan P. The elephant in the room: too much medicine in musculoskeletal practice. *J Orthop Sports Phys Ther*. 2020;50:1–4.
53. Martin RL, Chimenti R, Cuddeford T, Houck J, Matheson JW, McDonough CM, et al. Achilles pain, stiffness, and muscle power deficits: Midportion Achilles tendinopathy revision 2018: Clinical practice guidelines linked to the International Classification of Functioning, Disability and Health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2018;48:A1–A38.
54. Jozsa L, Kannus P. Histopathological findings in spontaneous tendon ruptures. *Scand J Med Sci Sports*. 1997;7:113–118.
55. Malliaras P, Cook J, Purdam C, Rio E. Patellar tendinopathy: clinical diagnosis, load management, and advice for challenging case presentations. *J Orthop Sports Phys Ther*. 2015;45:887–898.
56. Thomeé R. A comprehensive treatment approach for patellofemoral pain syndrome in young women. *Phys Ther*. 1997;77:1690–1703.
57. Von Korff M, DeBar LL, Krebs EE, Kerns RD, Deyo RA, Keefe FJ. Graded chronic pain scale revised: mild, bothersome, and high impact chronic pain. *Pain*. 2020;161:651.
58. Murphy MC, Travers MJ, Chivers P, Debenham JR, Docking SI, Rio EK, et al. Efficacy of heavy eccentric calf training for treating mid-portion Achilles tendinopathy: a systematic review and meta-analysis. *Brit J Sports Med*. 2019;53:1070–1077.
59. Oskouei ST, Malliaras P, Hill KD, Clark R, Perraton L. Evaluating daily physical activity and biomechanical measures using wearable technology in people with Achilles tendinopathy: A descriptive exploratory study. *Musculoskeletal Sci Prac*. 2022;58:102534.
60. Turk DC. *The biopsychosocial approach to the assessment and intervention for people with musculoskeletal disorders. Handbook of Musculoskeletal Pain and Disability Disorders in the Workplace*. Springer; 2014:341–363.
61. Hasani F, Vallance P, Haines T, Munteanu SE, Malliaras P. Are Plantarflexor Muscle Impairments Present Among Individuals with Achilles Tendinopathy and Do They Change with Exercise? A Systematic Review with Meta-analysis. *Sports Med Open*. 2021;7:1–18.
62. McAuliffe S, Tabuena A, McCreesh K, O'Keeffe M, Hurley J, Comyns T, et al. Altered strength profile in Achilles tendinopathy: a systematic review and meta-analysis. *J Athl Train*. 2019;54:889–900.
63. Ogbonmwan I, Kumar BD, Paton B. New lower-limb gait biomechanical characteristics in individuals with Achilles tendinopathy: a systematic review update. *Gait Posture*. 2018;62:146–156.
64. Sancho I, Malliaras P, Barton C, Willy RW, Morrissey D. Biomechanical alterations in individuals with Achilles tendinopathy during running and hopping: A systematic review with meta-analysis. *Gait Posture*. 2019;73:189–201.
65. Hanlon SL, Pohlig RT, Silbernagel KG. Beyond the diagnosis: using patient characteristics and domains of tendon health to identify latent subgroups of Achilles tendinopathy. *J Orthop Sports Phys Ther*. 2021;51:440–448.
66. Mallows A, Debenham J, Walker T, Littlewood C. Association of psychological variables and outcome in tendinopathy: a systematic review. *Brit J Sports Med*. 2017;51:743–748.
67. Stubbs C, Mc Auliffe S, Mallows A, O'sullivan K, Haines T, Malliaras P. The strength of association between psychological factors and clinical outcome in tendinopathy: A systematic review. *PloS one*. 2020;15:e0242568.
68. Robinson J, 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. *Brit J Sports Med*. 2001;35:335–341.
69. Hasenbring MI, Verbunt JA. Fear-avoidance and endurance-related responses to pain: new models of behavior and their consequences for clinical practice. *Clin J Pain*. 2010;26:747–753.
70. Hébert-Losier K, Wessman C, Alricsson M, Svantesson U. Updated reliability and normative values for the standing heel-rise test in healthy adults. *Physiotherapy*. 2017;103:446–452.
71. Albracht K, Arampatzis A, Baltzopoulos V. Assessment of muscle volume and physiological cross-sectional area of the human triceps surae muscle in vivo. *J Biomech*. 2008;41:2211–2218.
72. Reid D, McNair PJ, Johnson S, Potts G, Witvrouw E, Mahieu N. Electromyographic analysis of an eccentric calf muscle exercise in persons with and without Achilles tendinopathy. *Phys Ther Sport*. 2012;13:150–155.
73. Habets B, Smits H, Backx F, Van Cingel R, Huisstede B. Hip muscle strength is decreased in middle-aged recreational male athletes with midportion Achilles tendinopathy: a cross-sectional study. *Phys Ther Sport*. 2017;25:55–61.
74. Sancho I, Morrissey D, Willy RW, Tayfur A, Lascurain-Aguirrebeña I, Barton C, et al. Recreational runners with Achilles tendinopathy have clinically detectable impairments: A case-control study. *Phys Ther Sport*. 2022;55:241–247.
75. O'Neill S, Watson PJ, Barry S. Why are eccentric exercises effective for achilles tendinopathy? *Int J Sports Phys Ther*. 2015;10:552.
76. Lyght M, Nockerts M, Kernozek TW, Ragan R. Effects of foot strike and step frequency on Achilles tendon stress during running. *J Appl Biomech*. 2016;32:365–372.
77. Plinsinga ML, Van Wilgen CP, Brink MS, Vuvan V, Stephenson A, Heales LJ, et al. Patellar and Achilles tendinopathies are predominantly peripheral pain states: a blinded case control study of somatosensory and psychological profiles. *Brit J Sports Med*. 2018;52:284–291.

78. Mc Auliffe S, Whiteley R, Malliaras P, O'Sullivan K. Central sensitisation in different tendinopathies: are we comparing apples and oranges? *Brit J Sports Med*. 2019;53:142–143.
79. Vallance P, Crowley L, Vicenzino B, Malliaras P. Contralateral mechanical hyperalgesia and altered pain modulation in men who have unilateral insertional Achilles tendinopathy: a cross-sectional study. *Musculoskeletal Sci Prac*. 2021;52: 102353.
80. Uddin Z, MacDermid JC. Quantitative sensory testing in chronic musculoskeletal pain. *Pain Med*. 2016;17:1694–1703.
81. Vicenzino B, de Vos R-J, Alfredson H, Bahr R, Cook JL, Coombes BK, et al. ICON 2019—International Scientific Tendinopathy Symposium Consensus: There are nine core health-related domains for tendinopathy (CORE DOMAINS): Delphi study of healthcare professionals and patients. *Brit J Sports Med*. 2020;54:444–451.
82. Mallows AJ, Debenham JR, Malliaras P, Stace R, Littlewood C. Cognitive and contextual factors to optimise clinical outcomes in tendinopathy. *Brit J Sports Med*. 2018;52:822–823.
83. Färnqvist K, Morrissey D, Malliaras P. Factors associated with outcome following exercise interventions for Achilles tendinopathy: a systematic review. *Physiother Res Int*. 2021;26:e1889.
84. Mallows A, Jackson J, Littlewood C, Debenham J. The association of working alliance, outcome expectation, adherence and self-efficacy with clinical outcomes for Achilles tendinopathy: A feasibility cohort study (the MAP study). *Musculoskel Care*. 2020;18:169–176.
85. Chimenti RL, Post AA, Rio EK, Moseley GL, Dao M, Mosby H, et al. The effects of pain science education plus exercise on pain and function in chronic Achilles tendinopathy: A blinded, placebo-controlled, explanatory randomized trial. *Pain*. 2022: 10.1097.
86. Littlewood C, Malliaras P, Bateman M, Stace R, May S, Walters S. The central nervous system–an additional consideration in 'rotator cuff tendinopathy'and a potential basis for understanding response to loaded therapeutic exercise. *Man Ther*. 2013;18:468–472.
87. Bassett SF. Bridging the intention-behaviour gap with behaviour change strategies for physiotherapy rehabilitation non-adherence. *N Z J Physiother*. 2015;43:105–111.
88. Rabusin CL, Menz HB, McClelland JA, Evans AM, Malliaras P, Docking SI, et al. Efficacy of heel lifts versus calf muscle eccentric exercise for mid-portion Achilles tendinopathy (HEALTHY): a randomised trial. *Brit J Sports Med*. 2021;55:486–492.
89. Stergioulas A, Stergioula M, Aarskog R, Lopes-Martins RA, Bjordal JM. Effects of low-level laser therapy and eccentric exercises in the treatment of recreational athletes with chronic achilles tendinopathy. *Am J Sports Med*. 2008;36: 881–887.
90. Horstmann T, Jud HM, Fröhlich V, Mündermann A, Grau S. Whole-body vibration versus eccentric training or a wait-and-see approach for chronic Achilles tendinopathy: a randomized clinical trial. *J Orthop Sports Phys Ther*. 2013;43:794–803.
91. Beyer R, Kongsgaard M, Hougs Kjær B, Øhlenschlæger T, Kjær M, Magnusson SP. Heavy slow resistance versus eccentric training as treatment for Achilles tendinopathy: a randomized controlled trial. *Am J Sports Med*. 2015;43:1704–1711.
92. Gatz M, Betsch M, Dirrichs T, Schrading S, Tingart M, Michalik R, et al. Eccentric and isometric exercises in Achilles tendinopathy evaluated by the VISA-A score and shear wave elastography. *Sports Health*. 2020;12:373–381.
93. Habets B, van Cingel RE, Backx FJ, van Elten HJ, Zuithoff P, Huisstede BM. No difference in clinical effects when comparing alfredson eccentric and silbernagel combined concentric-eccentric loading in achilles tendinopathy: a randomized controlled trial. *Orthop J Sports Med*. 2021;9:23259671211031254.
94. 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;9:42–47.
95. Nørregaard J, Larsen C, Bieler T, Langberg H. Eccentric exercise in treatment of Achilles tendinopathy. *Scand J Med Sci Sports*. 2007;17:133–138.
96. Stasinopoulos D, Manias P. Comparing two eccentric exercise programmes for the management of Achilles tendinopathy. A pilot trial. *J Bodyw Mov Ther*. 2013;17:309–315.
97. Stevens M, Tan C-W. Effectiveness of the Alfredson protocol compared with a lower repetition-volume protocol for midportion Achilles tendinopathy: a randomized controlled trial. *J Orthop Sports Phys Ther*. 2014;44:59–67.
98. Tumilty S, Mani R, Baxter GD. Photobiomodulation and eccentric exercise for Achilles tendinopathy: a randomized controlled trial. *Lasers Med Sci*. 2016;31:127–135.
99. Yu J, Park D, Lee G. Effect of eccentric strengthening on pain, muscle strength, endurance, and functional fitness factors in male patients with achilles tendinopathy. *Am J Phys Med Rehabil*. 2013;92:68–76.
100. de Jonge S, de Vos R-J, Van Schie HT, Verhaar JA, Weir A, Tol JL. One-year follow-up of a randomised controlled trial on added splinting to eccentric exercises in chronic midportion Achilles tendinopathy. *Brit J Sports Med*. 2010;44:673–677.
101. De Vos R, Weir A, Visser R, de Winter T, Tol J. The additional value of a night splint to eccentric exercises in chronic midportion Achilles tendinopathy: a randomised controlled trial. *Brit J Sports Med*. 2007;41:e5-e5.
102. McAleenan M, McVeigh J, Cullen M, Sayers F, McCrea K, Baxter D. The effectiveness of night splints in achilles tendinopathy: a pilot study. *Physiother Prac Res*. 2010;31:28–33.
103. McCormack JR, Underwood FB, Slaven EJ, Cappaert TA. Eccentric exercise versus eccentric exercise and soft tissue treatment (Astym) in the management of insertional Achilles tendinopathy: a randomized controlled trial. *Sports Health*. 2016;8:230–237.
104. Munteanu SE, Scott LA, Bonanno DR, Landorf KB, Pizzari T, Cook JL, et al. Effectiveness of customised foot orthoses for Achilles tendinopathy: a randomised controlled trial. *Brit J Sports Med*. 2015;49:989–994.
105. Petersen W, Welp R, Rosenbaum D. Chronic Achilles tendinopathy: a prospective randomized study comparing the therapeutic effect of eccentric training, the AirHeel brace, and a combination of both. *Am J Sports Med*. 2007;35:1659–1667.
106. Tumilty S, McDonough S, Hurley DA, Baxter GD. Clinical effectiveness of low-level laser therapy as an adjunct to eccentric exercise for the treatment of Achilles' tendinopathy: a randomized controlled trial. *Arch Phys Med Rehabil*. 2012;93:733–739.
107. Tumilty S, Munn J, Abbott JH, McDonough S, Hurley DA, Baxter GD. Laser therapy in the treatment of Achilles tendinopathy: a pilot study. *Photomed Laser Surg*. 2008;26:25–30.
108. Abdelkader NA, Helmy MNK, Fayaz NA, Saweeres ES. Short-and intermediate-term results of extracorporeal shockwave therapy for noninsertional Achilles tendinopathy. *Foot Ank Int*. 2021;42:788–797.
109. Gatz M, Schweda S, Betsch M, Dirrichs T, de la Fuente M, Reinhardt N, et al. Line- and point-focused extracorporeal shock wave therapy for Achilles tendinopathy: a placebo-controlled RCT study. *Sports Health*. 2021;13:511–518.
110. Mansur NSB, Matsunaga FT, Carrazzone OL, Dos Santos BS, Nunes CG, Aoyama BT, et al. Shockwave therapy plus eccentric exercises versus isolated eccentric exercises for Achilles insertional tendinopathy: a double-blinded ran domized clinical trial. *JBJS*. 2021;103:1295–1302.
111. Pinitkwamdee S, Laohajaroensombat S, Orapin J, Woratanarat P. Effectiveness of extracorporeal shockwave therapy in the treatment of chronic insertional Achilles tendinopathy. *Foot Ank Int*. 2020;41:403–410.
112. Rompe JD, Furia J, Maffulli N. Eccentric loading versus eccentric loading plus shock-wave treatment for midportion achilles tendinopathy: a randomized controlled trial. *Am J Sports Med*. 2009;37:463–470.
113. Vahdatpour B, Forouzan H, Momeni F, Ahmadi M, Taheri P. Effectiveness of extracorporeal shockwave therapy for chronic Achilles tendinopathy: a randomized clinical trial. *J Res Med Sci*. 2018;23.
114. Knobloch K, Schreibmueller L, Longo UG, Vogt PM. Eccentric exercises for the management of tendinopathy of the main body of the Achilles tendon with or without the AirHeel™ Brace. A randomized controlled trial. A: effects on pain and microcirculation. *Disabil Rehabil*. 2008;30:1685–1691.
115. Koszalinski A, Flynn T, Hellman M, Cleland J. Trigger point dry needling, manual therapy and exercise versus manual therapy and exercise for the management of Achilles tendinopathy: a feasibility study. *J Man Manip Ther*. 2020;28:212–221.
116. Herrington L, McCulloch R. The role of eccentric training in the management of Achilles tendinopathy: a pilot study. *Phys Ther Sport*. 2007;8:191–196.
117. Kedia M, Williams M, Jain L, Barron M, Bird N, Blackwell B, et al. The effects of conventional physical therapy and eccentric strengthening for insertional achilles tendinopathy. *Int J Sports Phys Ther*. 2014;9:488.
118. Rompe JD, Furia J, Maffulli N. Eccentric loading compared with shock wave treatment for chronic insertional achilles tendinopathy: a randomized, controlled trial. *JBJS*. 2008;90:52–61.
119. Roos EM, Engström M, Lagerquist A, Söderberg B. Clinical improvement after 6 weeks of eccentric exercise in patients with mid-portion Achilles tendinopathy–a randomized trial with 1-year follow-up. *Scand J Med Sci Sports*. 2004;14:286–295.
120. Wiedmann M, Mauch F, Huth J, Burkhardt P, Drews BH. Die Behandlung der Midportion-Achillessehnentendinopathie mit exzentrischem Krafttraining und dessen Auswirkung auf die Neovaskularisation. *Sports Orthop Traumatol*. 2017;33:278–285.
121. Benli MD, Tatari H, Balcı A, Peker A, Şimşek K, Yüksel O, et al. A comparison between the efficacy of eccentric exercise and extracorporeal shock wave therapy on tendon thickness, vascularity, and elasticity in Achilles tendinopathy: A randomized controlled trial. *Turk J Phys Med Rehabil*. 2022;68:372–380.
122. Chester R, Costa ML, Shepstone L, Cooper A, Donell ST. Eccentric calf muscle training compared with therapeutic ultrasound for chronic Achilles tendon pain—a pilot study. *Man Ther*. 2008;13:484–491.
123. Solomons L, Lee JJ, Bruce M, White LD, Scott A. Intramuscular stimulation vs sham needling for the treatment of chronic midportion Achilles tendinopathy: a randomized controlled clinical trial. *PloS one*. 2020;15:e0238579.
124. Stefansson SH, Brandsson S, Langberg H, Arnason A. Using pressure massage for Achilles tendinopathy: a single-blind, randomized controlled trial comparing a novel treatment versus an eccentric exercise protocol. *Orthop J Sports Med*. 2019;7: 2325967119834284.
125. Zhang B-m, Zhong L-w, Xu S-w, Jiang H-r, Shen J. Acupuncture for chronic Achilles tendnopathy: a randomized controlled study. *Chin J Integr Med*. 2013;19:900–904.
126. Van Der Vlist AC, Winters M, Weir A, Weir A, Ardern CL, Welton NJ, et al. Which treatment is most effective for patients with Achilles tendinopathy? A living systematic review with network meta-analysis of 29 randomised controlled trials. *Brit J Sports Med*. 2021;55:249–256.
127. Merry K, Napier C, Waugh CM, Scott A. Foundational Principles and Adaptation of the Healthy and Pathological Achilles Tendon in Response to Resistance Exercise: A Narrative Review and Clinical Implications. *J Clin Med*. 2022;11:4722.
128. Öhberg L, Alfredson H. Effects on neovascularisation behind the good results with eccentric training in chronic mid-portion Achilles tendinosis? *Knee Surg Sports Traumatol Arthrosc*. 2004;12:465–470.
129. Langberg H, Ellingsgaard H, Madsen T, Jansson J, Magnusson SP, Aagaard P, et al. Eccentric rehabilitation exercise increases peritendinous type I collagen synthesis in humans with Achilles tendinosis. *Scand J Med Sci Sports*. 2007;17:61–66.
130. Smith BE, Hendrick P, Bateman M, Holden S, Littlewood C, Smith TO, et al. Musculoskeletal pain and exercise—challenging existing paradigms and introducing new. *Brit J Sports Med*. 2019;53:907–912.
131. Tol JL, Spiezia F, Maffulli N. Neovascularization in Achilles tendinopathy: have we been chasing a red herring? Arthros*copy*. 2012;10:1891–1894.

132. Drew BT, Smith TO, Littlewood C, Sturrock B. Do structural changes (eg, collagen/matrix) explain the response to therapeutic exercises in tendinopathy: a systematic review. *Brit J Sports Med*. 2014;48:966–972.
133. Smith BE, Hendrick P, Smith TO, Bateman M, Moffatt F, Rathleff MS, et al. Should exercises be painful in the management of chronic musculoskeletal pain? A systematic review and meta-analysis. *Brit J Sports Med*. 2017;51:1679–1687.
134. Coronado RA, Brintz CE, McKernan LC, Master H, Motzny N, Silva FM, et al. Psychologically informed physical therapy for musculoskeletal pain: current approaches, implications, and future directions from recent randomized trials. *Pain Rep*. 2020;5.
135. Clifford C, Challoumas D, Paul L, Syme G, Millar NL. Effectiveness of isometric exercise in the management of tendinopathy: a systematic review and meta-analysis of randomised trials. *BMJ Open Sport Ex Med*. 2020;6:e000760.
136. Yeh CH, Calder JD, Antflick J, Bull AM, Kedgley AE. Maximum dorsiflexion increases Achilles tendon force during exercise for midportion Achilles tendinopathy. *Scand J Med Sci Sports*. 2021;31:1674–1682.
137. Silbernagel KG, Thomeé R, Eriksson BI, Karlsson J. Full symptomatic recovery does not ensure full recovery of muscle-tendon function in patients with Achilles tendinopathy. *Brit J Sports Med*. 2007;41:276–280.
138. Mahieu NN, Witvrouw E, Stevens V, Van Tiggelen D, Roget P. Intrinsic risk factors for the development of achilles tendon overuse injury: a prospective study. *Am J Sports Med*. 2006;34:226–235.
139. Bird SP, Tarpenning KM, Marino FE. Designing resistance training programmes to enhance muscular fitness. *Sports Med*. 2005;35:841–851.
140. Enoka RM. Eccentric contractions require unique activation strategies by the nervous system. *J Appl Physiol*. 1996;81:2339–2346.
141. Agyi TH, Devita P, Money J, Barrier J. Effects of standard and eccentric overload strength training in young women. *Med Sci Sports Exerc*. 2001;33:1206–1212.
142. Naclerio F, Rodríguez-Romo G, Barriopedro-Moro MI, Jiménez A, Alvar BA, Triplett NT. Control of resistance training intensity by the OMNI perceived exertion scale. *J Strength Condit Res*. 2011;25:1879–1888.
143. Morishita S, Tsubaki A, Takabayashi T, Fu JB. Relationship between the rating of perceived exertion scale and the load intensity of resistance training. *Strength Condit J*. 2018;40:94.
144. Sancho I, Morrissey D, Willy RW, Barton C, Malliaras P. Education and exercise supplemented by a pain-guided hopping intervention for male recreational runners with midportion Achilles tendinopathy: a single cohort feasibility study. *Phys Ther Sport*. 2019;40:107–116.
145. Oranchuk DJ, Storey AG, Nelson AR, Cronin JB. Isometric training and long-term adaptations: Effects of muscle length, intensity, and intent: A systematic review. *Scand J Med Sci Sports*. 2019;29:484–503.
146. Lieber RL. *Skeletal muscle structure, function, and plasticity*. Lippincott Williams & Wilkins; 2002.
147. Costa M, Shepstone L, Donell S, Thomas T. Shock wave therapy for chronic Achilles tendon pain: a randomized placebo-controlled trial. *Clin Orthop Relat Res*. 2005;440:199–204.
148. Hutchison A, Pallister I, Evans R, Bodger O, Topliss CJ, Williams P, et al. Intense pulsed light treatment of chronic mid-body achilles tendinopathy: a double blind randomised placebo-controlled trial. *Bone Jy J*. 2013;95:504–509.
149. Kishmishian B, Richards J, Selfe J. A randomised feasibility study using an acupuncture protocol to the Achilles tendon in Achilles tendinopathy. *Physiother Prac Res*. 2019;40:59–67.
150. Fahlström 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.
151. Jonsson P, Alfredson H, Sunding K, Fahlström M, Cook J. New regimen for eccentric calf-muscle training in patients with chronic insertional Achilles tendinopathy: results of a pilot study. *Brit J Sports Med*. 2008;42:746–749.
152. Testa M, Rossettini G. Enhance placebo, avoid nocebo: How contextual factors affect physiotherapy outcomes. *Man Ther*. 2016;24:65–74.
153. Grävare Silbernagel K, Malliaras P, de Vos R-J, Hanlon S, Molenaar M, Alfredson H, et al. ICON 2020—International Scientific Tendinopathy Symposium Consensus: a systematic review of outcome measures reported in clinical trials of Achilles tendinopathy. *Sports Med*. 2021:1–29.
154. Yin N-H, Fromme P, McCarthy I, Birch HL. Individual variation in Achilles tendon morphology and geometry changes susceptibility to injury. *Elife*. 2021;10:e63204.
155. Chimenti RL, Post AA, Silbernagel KG, Hadlandsmyth K, Sluka KA, Moseley GL, et al. Kinesiophobia Severity Categories and Clinically Meaningful Symptom Change in Persons With Achilles Tendinopathy in a Cross-Sectional Study: Implications for Assessment and Willingness to Exercise. *Front Pain Res*. 2021:57.
156. Lagas IF, van der Vlist AC, van Oosterom RF, van Veldhoven PL, Reijman M, Verhaar JA, et al. Victorian Institute of Sport Assessment-Achilles (VISA-A) Questionnaire—Minimal Clinically Important Difference for Active People With Midportion Achilles Tendinopathy: A Prospective Cohort Study. *J Orthop Sports Phys Ther*. 2021;51:510–516.
157. Mallows A, Littlewood C, Malliaras P. Measuring patient-reported outcomes (PROs/PROMs) in people with Achilles tendinopathy: how useful is the VISA-A? *Brit J Sports Med*. 2018;52:1221–1221.
158. Comins J, Siersma V, Couppe C, Svensson RB, Johansen F, Malmgaard-Clausen NM, et al. Assessment of content validity and psychometric properties of VISA-A for Achilles tendinopathy. *PloS one*. 2021;16:e0247152.
159. Abate M, Salini V. Mid-portion Achilles tendinopathy in runners with metabolic disorders. *Eur J Orthop Surg Traumatol*. 2019;29:697–703.
160. Ahn HS, Kim HJ, Kang TU, Kazmi SZ, Suh JS, Young Choi J. Dyslipidemia Is associated with increased risk of Achilles tendon disorders in underweight individuals to a greater extent than obese individuals: A nationwide, population-based, longitudinal cohort study. *Orthop J Sports Mede*. 2021;9:23259671211042599.
161. Gaida J, Alfredson L, Kiss Z, Wilson A, Alfredson H, Cook J. Dyslipidemia in Achilles tendinopathy is characteristic of insulin resistance. *Med Sci Sports Ex*. 2009;41:1194.
162. Holmes GB, Lin J. Etiologic factors associated with symptomatic achilles tendinopathy. *Foot Ank Int*. 2006;27:952–959.
163. Watt FE. Musculoskeletal pain and menopause. *Post Reproduct Health*. 2018;24:34–43.
164. Oliva F, Piccirilli E, Berardi AC, Frizziero A, Tarantino U, Maffulli N. Hormones and tendinopathies: the current evidence. *Brit Med Bull*. 2016;117:39–58.
165. Owens BD, Wolf JM, Seelig AD, Jacobson IG, Boyko EJ, Smith B, et al. Risk factors for lower extremity tendinopathies in military personnel. *Orthop J Sports Med*. 2013;1:2325967113492707.
166. Friedman DJ, Tulloh L, Khan KM. Peeling off musculoskeletal labels: sticks and stones may break my bones, but diagnostic labels can hamstring me forever. *Brit J Sports Med*. 2021;55:1184–1185.
167. Kraemer R, Wuerfel W, Lorenzen J, Busche M, Vogt PM, Knobloch K. Analysis of hereditary and medical risk factors in Achilles tendinopathy and Achilles tendon ruptures: a matched pair analysis. *Arch Orthop Trauma Surg*. 2012;132:847–853.
168. Wheeler PC. Nearly half of patients with chronic tendinopathy may have a neuropathic pain component, with significant differences seen between different tendon sites: a prospective cohort of more than 300 patients. *BMJ Open Sport Ex Med*. 2022;8:e001297.
169. Wang HK, Lin KH, Su SC, Shih TF, Huang YC. Effects of tendon viscoelasticity in A chilles tendinosis on explosive performance and clinical severity in athletes. *Scand J Med Sci Sports*. 2012;22:e147–e155.
170. Firth BL, Dingley P, Davies ER, Lewis JS, Alexander CM. The effect of kinesiotape on function, pain, and motoneuronal excitability in healthy people and people with Achilles tendinopathy. *Clin J Sport Med*. 2010;20:416–421.
171. Mc Auliffe S, Bisset L, Chester R, Coombes BK, Fearon A, Kirwan P, et al. ICON 2020—International Scientific Tendinopathy Symposium Consensus: A Scoping Review of Psychological and Psychosocial Constructs and Outcome Measures Reported in Tendinopathy Clinical Trials. *J Orthop Sports Phys Ther*. 2022;52:375–388.
172. Alghamdi NH, Pohlig RT, Lundberg M, Silbernagel KG. The impact of the degree of kinesiophobia on recovery in patients with achilles tendinopathy. *Phys Ther*. 2021;101:178.
173. Chester R, Jerosch-Herold C, Lewis J, Shepstone L. Psychological factors are associated with the outcome of physiotherapy for people with shoulder pain: a multicentre longitudinal cohort study. *Brit J Sports Med*. 2018;52:269–275.
174. Niesen-Vertommen S. *The effect of an eccentric-type exercise versus a concentric-type exercise in the management of chronic Achilles tendonitis*. University of British Columbia; 1989.
175. Stanish WD, Rubinovich RM, Curwin S. Eccentric exercise in chronic tendinitis. *Clin Orthop Relat Res*. 1986;208:65–68.
176. 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;26:360–366.
177. Gifford L. The mature organism model. *Whiplash—Science and Management: Fear, Avoidance Beliefs and Behaviour Topical Issues in Pain*. 2013;1:45–56.

Websites

Tame the Beast www.tamethebeast.org
Why Things Hurt www.youtube.com/watch?v=gwd-wLdIHs