CHRISTOPHER R. CARCIA, PT, PhD • **ROBROY L. MARTIN,** PT, PhD • **JEFF HOUCK,** PT, PhD • **DANE K. WUKICH,** MD

Achilles Pain, Stiffness, and Muscle Power Deficits: Achilles Tendinitis

Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association

Recommendations*

RISK FACTORS: For specific groups of individuals, clinicians should consider abnormal ankle dorsiflexion range of motion, abnormal subtalar joint range of motion, decreased ankle plantar flexion strength, increased foot pronation, and abnormal tendon structure as intrinsic risk factors associated with Achilles tendinopathy. Obesity, hypertension, hyperlipidemia, and diabetes are medical conditions associated with Achilles tendinopathy. Clinicians should also consider training errors, environmental factors, and faulty equipment as extrinsic risk factors associated with Achilles tendinopathy. (Recommendation based on moderate evidence.)

DIAGNOSIS/CLASSIFICATION: Self-reported localized pain and perceived stiffness in the Achilles tendon following a period of inactivity (ie, sleep, prolonged sitting), lessens with an acute bout of activity and may increase after the activity. Symptoms are frequently accompanied with Achilles tendon tenderness, a positive arc sign, and positive findings on the Royal London Hospital test. These signs and symptoms are useful clinical findings for classifying a patient with ankle pain into the ICD category of Achilles bursitis or tendinitis and the associated ICF impairment-based category of Achilles pain (b28015 Pain in lower limb), stiffness (b7800 Sensation of muscle stiffness), and muscle power deficits (b7301 Power of muscles of lower limb). (Recommendation based on weak evidence.)

DIFFERENTIAL DIAGNOSIS: Clinicians should consider diagnostic classifications other than Achilles tendinopathy when the patient's reported activity limitations or impairments of body function and structure are not consistent with those presented in the diagnosis/classification section of this guideline, or, when the patient's symptoms are not resolving with interventions aimed at normalization of the patient's impairments of body function. (Recommendation based on expert opinion.)

EXAMINATION – OUTCOME MEASURES: Clinicians should incorporate validated functional outcome measures, such as the Victorian Institute of Sport Assessment and the Foot and Ankle Ability Measure. These should be utilized before and after interventions intended to alleviate the impairments of body function and structure, activity limitations, and participation restrictions associated with Achilles tendinopathy. (Recommendation based on strong evidence.)

EXAMINATION – ACTIVITY LIMITATION AND PARTICIPATION RESTRICTION MEASURES: When evaluating functional limitations over an episode of care for those with Achilles tendinopathy, measures of activity limitation and participation restriction can include objective and reproducible assessment of the ability to walk, descend stairs, perform unilateral heel raises and single-limb hop, and participate in recreational activity. (Recommendation based on moderate evidence.)

EXAMINATION – PHYSICAL IMPAIRMENT MEASURES: When evaluating physical impairment over an episode of care for those with Achilles tendinopathy, one should consider measuring dorsiflexion range of motion, subtalar joint range of motion, plantar flexion strength and endurance, static arch height, forefoot alignment, and pain with palpation. (Recommendations based on moderate evidence.)

INTERVENTIONS – ECCENTRIC LOADING: Clinicians should consider implementing an eccentric loading program to decrease pain and improve function in patients with midportion Achilles tendinopathy. (Recommendation based on strong evidence.)

INTERVENTIONS – LOW-LEVEL LASER THERAPY: Clinicians should consider the use of low-level laser therapy to decrease pain and stiffness in patients with Achilles tendinopathy. (Recommendation based on moderate evidence.)

INTERVENTIONS – IONTOPHORESIS: Clinicians should consider the use of iontophoresis with dexamethasone to decrease pain and improve function in patients with Achilles tendinopathy. (Recommendation based on moderate evidence.)

INTERVENTIONS – STRETCHING: Stretching exercises can be used to reduce pain and improve function in patients who exhibit limited dorsiflexion range of motion with Achilles tendinopathy. (Recommendation based on weak evidence).

INTERVENTIONS – FOOT ORTHOSES: A foot orthosis can be used to reduce pain and alter ankle and foot kinematics while running in patients with Achilles tendinopathy. (Recommendation based on weak evidence.)

INTERVENTIONS – MANUAL THERAPY: Soft tissue mobilization can be used to reduce pain and improve mobility and function in patients with Achilles tendinopathy. (Recommendation based on expert opinion.)

INTERVENTIONS – TAPING: Taping may be used in an attempt to decrease strain on the Achilles tendon in patients with Achilles tendinopathy. (Recommendation based on expert opinion.)

INTERVENTIONS – HEEL LIFT: Contradictory evidence exists for the use of heel lifts in patients with Achilles tendinopathy. (Recommendation based on conflicting evidence.)

INTERVENTIONS – NIGHT SPLINT: Night splints are not beneficial in reducing pain when compared to eccentric exercise for patients with Achilles tendinopathy. (Recommendation based on weak evidence.)

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*These recommendations and clinical practice guidelines are based on the scientific literature published prior to February 2009.

Introduction

AIM OF THE GUIDELINE

The Orthopaedic Section of the American Physical Therapy Association (APTA) has an ongoing effort to create evidence-based practice guidelines for orthopaedic physical therapy management of patients with musculoskeletal impairments described in the World Health Organization's International Classification of Functioning, Disability, and Health (ICF).[135]

The purposes of these clinical guidelines are to:

• Describe evidence-based physical therapy practice including diagnosis, prognosis, intervention, and assessment of outcome for musculoskeletal disorders commonly managed by orthopaedic physical therapists
• Classify and define common musculoskeletal conditions using the World Health Organization's terminology related to impairments of body function and body structure, activity limitations, and participation restrictions
• Identify interventions supported by current best evidence to address impairments of body function and structure, activity limitations, and participation restrictions associated with common musculoskeletal conditions
• Identify appropriate outcome measures to assess changes resulting from physical therapy interventions in body function and structure, as well as in activity and participation of the individual
• Provide a description to policy makers, using internationally accepted terminology, of the practice of orthopaedic physical therapists
• Provide information for payors and claims reviewers regarding the practice of orthopaedic physical therapy for common musculoskeletal conditions
• Create a reference publication for orthopaedic physical therapy clinicians, academic instructors, clinical instructors, students, interns, residents, and fellows regarding the best current practice of orthopaedic physical therapy

STATEMENT OF INTENT

This guideline is not intended to be construed or to serve as a standard of clinical care. Standards of care are determined on the basis of all clinical data available for an individual patient and are subject to change as scientific knowledge and technology advance and patterns of care evolve. These parameters of practice should be considered guidelines only. Adherence to them will not ensure a successful outcome in every patient, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgment regarding a particular clinical procedure or treatment plan must be made in light of the clinical data presented by the patient, the diagnostic and treatment options available, and the patient's values, expectations, and preferences. However, we suggest the rationale for significant departures from accepted guidelines be documented in the patient's medical records at the time the relevant clinical decision is made.

Methods

Content experts were appointed by the Orthopaedic Section, APTA, as developers and authors of clinical practice guidelines for musculoskeletal conditions related to the Achilles tendon. These content experts were given the task to identify impairments of body function and structure, activity limitations, and participation restrictions, described using ICF terminology, that could (1) categorize patients into mutually exclusive impairment patterns upon which to base intervention strategies, and (2) serve as measures of changes in function over the course of an episode of care. The second task given to the content experts was to describe the supporting evidence for the identified impairment pattern classification as well as interventions for patients with activity limitations and impairments of body function and structure consistent with the identified impairment pattern classification. It was also acknowledged by the Orthopaedic Section APTA content experts that only performing a systematic search and review of the evidence related to diagnostic categories based on International Statistical Classification of Diseases and Health Related Problems (ICD)[135] terminology would not be sufficient for these ICF-based clinical practice guidelines as most of the evidence associated with changes in levels of impairment or function in homogeneous populations is not readily searchable using the ICD terminology. For this reason, the content experts were directed to also search the scientific literature related to classification, outcome measures, and intervention strategies for musculoskeletal conditions commonly treated by physical therapists. Thus, the authors of this guideline independently performed a systematic search of the MEDLINE, CINAHL, and the Cochrane Database of Systematic Reviews

Methods *(continued)*

(1967 through February 2009) for any relevant articles related to classification, examination, and intervention for musculoskeletal conditions related to the Achilles tendon. Additionally, when relevant articles were identified, their reference lists were hand-searched in an attempt to identify additional articles that might contribute to the outcome of this guideline. Articles from the searches were compiled and reviewed for accuracy by the authors. Articles with the highest levels of evidence that were most relevant to classification, examination, and intervention for patients musculoskeletal conditions related to the Achilles tendon were included in this guideline.

This guideline was issued in 2010, based upon publications in the scientific literature prior to February 2009. This guideline will be considered for review in 2014, or sooner if new evidence becomes available. Any updates to the guideline in the interim period will be noted on the Orthopaedic Section of the APTA website: www.orthopt.org

LEVELS OF EVIDENCE

Individual clinical research articles will be graded according to criteria described by the Center for Evidence-Based Medicine, Oxford, United Kingdom (http://www.cebm.net) for diagnostic, prospective, and therapeutic studies.[101] An abbreviated version of the grading system is provided below (**TABLE 1**). The complete table of criteria and details of the grading can be found on the web at http://www.cebm.net.

I	Evidence obtained from high-quality diagnostic studies, prospective studies, or randomized controlled trials
II	Evidence obtained from lesser-quality diagnostic studies, prospective studies, or, randomized controlled trials (eg, weaker diagnostic criteria and reference standards, improper randomization, no blinding, <80% follow-up)
III	Case-controlled studies or retrospective studies
IV	Case series
V	Expert opinion

GRADES OF EVIDENCE

The overall strength of the evidence supporting recommendations made in this guideline were graded according to guidelines described by Guyatt et al,[42] as modified by Mac-Dermid and adopted by the coordinator and reviewers of this project. In this modified system, the typical A, B, C, and D grades of evidence have been modified to include the role of consensus expert opinion and basic science research to demonstrate biological or biomechanical plausibility (**TABLE 2**).

GRADES OF RECOMMENDATION BASED ON		STRENGTH OF EVIDENCE
A	Strong evidence	A preponderance of level I and/or level II studies support the recommendation. This must include at least 1 level I study
B	Moderate evidence	A single high-quality randomized controlled trial or a preponderance of level II studies support the recommendation
C	Weak evidence	A single level II study or a preponderance of level III and IV studies including statements of consensus by content experts support the recommendation
D	Conflicting evidence	Higher-quality studies conducted on this topic disagree with respect to their conclusions. The recommendation is based on these conflicting studies
E	Theoretical/ foundational evidence	A preponderance of evidence from animal or cadaver studies, from conceptual models/principles, or from basic sciences/bench research support this conclusion
F	Expert opinion	Best practice based on the clinical experience of the guidelines development team

REVIEW PROCESS

The Orthopaedic Section, APTA also selected consultants from the following areas to serve as reviewers of the early drafts of this clinical practice guideline:

- Basic science in tendon pathology and healing
- Claims review
- Coding
- Epidemiology
- Rheumatology
- Foot and Ankle Special Interest Group of the Orthopaedic Section, APTA
- Medical practice guidelines
- Orthopaedic physical therapy residency education
- Physical therapy academic education
- Sports physical therapy residency education
- Sports rehabilitation

Comments from these reviewers were utilized by the authors to edit this clinical practice guideline prior to submitting it for publication to the *Journal of Orthopaedic & Sports Physi-*

Methods *(continued)*

cal Therapy. In addition, several physical therapists practicing in orthopaedic and sports physical therapy settings were sent initial drafts of this clinical practice guideline, along with feedback forms to assess its usefulness, validity, and impact.

CLASSIFICATION

Commonly used terminology to describe disorders of the Achilles tendon can often be confusing. The terms "tendinitis," "tendonitis," or "paratenonitis" suggest that an inflammatory condition is present. However, while inflammation of the paratenon can occur,[89] inflammatory cells are generally absent.[10,73,91] Lacking the presence of inflammatory cells, degeneration of the tendon (tendinosis) is typically evident. In either case the terms "tendinitis" or "tendinosis" may be misleading and should be replaced with "tendinopathy," unless histological evidence has proven otherwise. Also the terminology used to describe the disorder should be tissue specific. Disorders of the tendon, paratenon, or both should be referred to as "tendinopathy," "paratendinopathy," or "pantendinopathy," respectively.[72,76] Another area of potential confusion relates to the location of the pathology. Achilles disorders are frequently described at 2 anatomical locations: (1) midportion (2-6 cm proximal to the insertion) of the tendon and (2) calcaneal insertion. Of these, those that afflict the midportion of the tendon are the most common.[61] In light of this, disorders of the midportion of the tendon described as "Achilles tendinopathy" will be the focus of this clinical guideline unless otherwise stated.

The ICD-10 code associated with Achilles tendinopathy is **M76.6 Achilles Tendinitis/Achilles bursitis**. The corresponding primary ICD-9 CM code, commonly used in the USA, is **726.71 Achilles bursitis or tendinitis.**

The primary ICF body function codes associated with Achilles tendinopathy are **b28015 Pain in lower limb, b7300 Power of isolated muscles and muscle groups**, and **b7800 Sensation of muscle stiffness**. The primary ICF body structures codes associated with Achilles tendinopathy are **s75012 Muscles of lower leg** and **s75028 Structure of ankle and foot, specified as Achilles tendon**.

The primary ICF activities and participation codes associated with Achilles tendinopathy are **d4500 Walking short distances, d4501 Walking long distances, d4552 Running, d4553 Jumping,** and **d9201 Sports**. The primary and secondary ICD-10 and ICF codes associated with Achilles tendinopathy are provided in **TABLE 3** on the following page.

ICD-10 and ICF Codes Associated With Ankle Pain and Stiffness

INTERNATIONAL STATISTICAL CLASSIFICATION OF DISEASES AND RELATED HEALTH PROBLEMS

ICD-10	M76.6	Achilles tendinitis/Achilles bursitis

INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY, AND HEALTH

PRIMARY ICF CODES

Body functions	b28015	Pain in lower limb
	b7300	Power of isolated muscles and muscle groups
	b7800	Sensation of muscle stiffness
Body structure	s75012	Muscles of lower leg
	s75028	Structure of ankle and foot, specified as Achilles tendon
Activities and participation	d4500	Walking short distances
	d4501	Walking long distances
	d4552	Running
	d4553	Jumping
	d9201	Sports

SECONDARY ICF CODES

Body functions	b7100	Mobility of a single joint
	b7101	Mobility of several joints
	b7301	Power of muscles of one limb
	b7400	Endurance of isolated muscles
	b7401	Endurance of muscle groups
	b770	Gait pattern functions (antalgic gait)
Body Structure	s7502	Structure of ankle and foot
	s75022	Muscles of ankle and foot
Activities and participation	d2302	Completing daily routine
	d4350	Pushing with lower extremities
	d4551	Climbing
	d4600	Moving around within the home
	d4601	Moving around within buildings other than home
	d4602	Moving around outside the home and other buildings

CLINICAL GUIDELINES

Impairment/Function-Based Diagnosis

PREVALENCE

DISORDERS OF THE ACHILLES TENDON RANK AMONG THE most frequently reported overuse injuries in the literature.[19,60,76,78] The majority of those suffering from Achilles tendinopathy are individuals engaged in activity, most often at a recreational or competitive level.[59] The annual incidence of Achilles tendinopathy in runners has been reported to be between 7% and 9%.[45,59] The less active are not immune as a minority of cases have been reported in sedentary groups.[43,107] Although runners appear to be the most commonly affected cohort,[59,60,62,98] Achilles disorders have been reported in a wide variety of sports.[32,33,59,60,134] It was noted that athletes are more likely to become symptomatic when training as opposed to during competitive events.[45,134] While there is an increased prevalence of Achilles injury as age increases,[32,58] the mean age of those affected by Achilles disorders has been reported to be between 30 and 50 years.[78,100,110] While gender has not been overtly studied, data from multiple works suggest males are affected to a greater extent than females.[60,98,110]

PATHOANATOMICAL FEATURES

THE ACHILLES TENDON IS THE LARGEST[112] AND STRONGEST[13,95] tendon in the body. The Achilles serves as the conjoined tendon for the gastrocnemius and soleus muscles. On average, the tendon has been reported to be 15 cm in length from the muscle tendon junction to its insertion on the posterior aspect of the calcaneus.[95] Of this, approximately half of the tendon is comprised of fibers from the gastrocnemius and half from the soleus.[21] Along its course, the tendon changes shape and orientation. Proximally, the tendon is broad and flat. As the tendon descends, however, it takes on more of a rounded stature. With further descent, just proximal to its insertion, the Achilles once again becomes flattened as it broadly inserts into the posterior surface of the calcaneus. Spiraling causes fibers from the gastrocnemius to become oriented on the posterior and lateral portion of the tendon while fibers from the soleus become located on the anterior and medial portion of the tendon.[129] The tendon is not encased in a true synovial sheath but rather is surrounded by a paratenon, a single cell layer of fatty areolar tissue.[115] Blood supply to the tendon is evident at 3 locations: the muscle-tendon junction, along the course of the tendon, and at the tendon-bone insertion.[95] Vascular density is greatest proximally and least in the midportion of the tendon.[17,63] Nerve supply to the Achilles tendon is primarily from branches of the sural nerve.[13] Nerve fibers have also been detected in the ventral portion of the paratenon. Further, afferent mechanoreceptors have been sparsely detected at the Achilles tendon proper and surrounding areolar tissue.[13]

The Achilles tendon, similar to other tendons and dense connective tissue alike, undergoes morphologic and biomechanical changes with increasing age. Morphologic changes include, but are not limited to, decreased collagen diameter[28] and density,[128] decreased glycosaminoglycans and water content,[44] and increased nonreducible cross-links.[8] Biomechanically, the aging tendon is characterized by decreased tensile strength, linear stiffness, and ultimate load.[133] Other characteristics of the aging tendon include a decreased capacity for collagen synthesis[8] and the accumulation of degraded macromolecules in the matrix.[16] Histopathological changes in tendon are common in individuals over the age of 35.[49] A study of 891 ruptured tendons in humans revealed 97% of the observed histopathologic changes were degenerative in nature. Of these specimens, 397 (45%) were Achilles tendons.[49]

Acute irritation of a healthy (nondegenerated) Achilles tendon has been associated with inflammation of the paratenon. Localized swelling between the paratenon and Achilles can be visualized and palpated.[124] More commonly, however, symptoms are chronic in nature and are associated with a degenerated tendon.[48] Tendinosis is thought to be noninflammatory,[10,53] though this remains an active area of exploration.[37] Tendinosis has been described as being either of the lipoid or mucoid variety.[53] Lipoid degeneration, as the name implies, indicates the presence of fatty tissue deposited in the tendon. With mucoid degeneration, the normal white, glistening appearance of the tendon is lost and the tendon takes on a grayish or brown color which is mechanically softer.[53] The degenerated Achilles tendon, in addition to its color and substance changes, exhibits signs of increased vascularization or neovascularization.[57] The neovascularization has been reported to demonstrate an irregular (nonparallel) pattern and, on occasion, to display a nodular appearance.[10] Further, the abnormal neovascularization is accompanied by increases in varicose nerve fibers.[13] Increased tendon thickness has been observed in subjects with symptomatic Achilles tendi-

nopathy.[57] However, a recent study linked abnormal tendon structure and symptoms but not tendon thickness, emphasizing the association of internal tendon structure with pain.[38] However, as classic signs of inflammation are typically not evident, the source of the pain in subjects with tendinopathy remains less certain. The involvement of neuropeptides in tendinopathy and the nervous system in tendon healing is an emerging area of research.[1,116] It has been observed that neovascularization is accompanied by an in-growth of nerve fascicles.[9] These nerve fibers have both sensory and sympathetic components and may in part be responsible for the pain associated with Achilles tendinopathy.[9] Other theories suggest neurotransmitters (ie, glutamate), which have been detected in heightened concentrations in pathologic specimens, may also explain the pain associated with Achilles tendinopathy.[6]

RISK FACTORS

NUMEROUS RISK FACTORS HAVE BEEN PROPOSED TO increase the likelihood of an individual developing an Achilles tendon disorder. Risk factors are commonly classified as those that are intrinsic or extrinsic to the individual. Intrinsic risk factors that have been associated with Achilles tendon disorders include abnormal ankle dorsiflexion range of motion, abnormal subtalar joint range of motion, decreased ankle plantar flexion strength, increased foot pronation, and associated diseases. It is theorized that the etiology of chronic tendon disorders results from an interaction of both intrinsic and extrinsic factors.[109]

INTRINSIC RISK FACTORS

I **Dorsiflexion Range of Motion** ABNORMAL dorsiflexion range of motion, either decreased[51] or increased,[79] has been associated with a higher incidence or risk of Achilles tendinopathy. In a 2-year prospective study, Kaufman et al[51] found that less than 11.5° of dorsiflexion, measured with the knee extended, increased the risk of developing Achilles tendinopathy by a factor of 3.5, when compared to those who exhibited between 11.5° and 15° of dorsiflexion. In a similar study, Mahieu et al[79] prospectively examined intrinsic risk factors associated with developing Achilles tendinopathy in a group of 69 military recruits. The authors identified that subjects with increased dorsiflexion range of motion (>9°) were at a heightened risk for developing Achilles tendinopathy. However, the level of increased risk was low and added little to a logistic regression analysis predicting the occurrence of Achilles tendinopathy. Clinically, patients who exhibit decreased dorsiflexion with the knee extended are theorized to experience increased tension on the Achilles tendon and hence be at a greater risk of tendinopathy. How an increase in dorsiflexion range of motion likewise increases this risk is less clear.

II **Abnormal Subtalar Range of Motion** Abnormalities (increases or decreases) in subtalar range of motion have also been reported to be associated with Achilles tendinopathy.[51,60] Kaufman et al[51] identified that inversion range of motion in excess of 32.5° increased Achilles tendinopathy risk by a factor of 2.8 when compared to those who displayed motion between 26° and 32.5°.[51] Conversely, other work has identified subjects with a decrease in total (inversion and eversion) passive subtalar joint range of motion (<25°) to be at an increased risk of Achilles tendinopathy.[60]

II **Decreased Plantar Flexion Strength** Decreased plantar flexion strength has been associated with Achilles pathology.[79,86,118] McCrory et al[86] noted a 4-Nm difference in isokinetic plantar flexion strength when comparing the strength of a healthy group of runners to the unaffected ankle in a group of injured runners. While statistically significant, it is unlikely that a 4 Nm difference is clinically important. In fact, it has been shown that there is a 6% to 11% difference between the left and right ankles when testing plantar flexor strength.[24] A more recent study prospectively identified that decreased plantar flexion torque as tested on an isokinetic dynamometer (30°/s and 120°/s) with the knee extended was a discriminating factor between Belgium military recruits who developed (n = 10) and those who did not develop (n = 59) Achilles tendinopathy during 6 weeks of basic training.[79] At 30°/s and 120°/s, the uninjured group generated 17.7 and 11.1 more Nm, respectively, when compared to the group that ultimately developed Achilles tendinopathy.[79] Because this study focused on male military recruits, this finding may be specific to young individuals with low plantar flexion strength levels (<50 Nm) pretraining. In other work, Silbernagel and colleagues[118] reported that subjects with Achilles tendinopathy (n = 42) had a decreased capacity to perform a maximal concentric heel raise, as well as a maximal eccentric-concentric heel raise, when comparing the affected to the unaffected or least affected side (when the pathology was present bilaterally). Thus, based on these works, it seems that individuals with decreased plantar flexion strength are at a heightened risk of developing Achilles tendinopathy and those with Achilles tendinopathy exhibit a decreased ability to generate a plantar flexion torque.

II **Pronation** As it relates to pronation, comparing a healthy (n = 58) and injured group of runners with Achilles tendinopathy (n = 31), McCrory et al[86] identified that the injured group had more calcaneal inversion at initial contact, displayed greater pronation, and took less time to achieve maximal pronation. Likewise, other work has identified a significant relationship between Achilles tendinopathy and a forefoot varus structural abnormality.[60] While a relationship between Achilles tendinopathy and increased foot pronation has been documented, a cause-

and-effect relationship has yet to be established. Increased pronation has been observed to cause a "whipping effect" on the Achilles and is hypothesized to decrease blood flow to the Achilles tendon.[19] Further, given that the Achilles tendon is located medial to the subtalar joint axis, it assumes some responsibility with decelerating pronation. Lastly, given the Achilles tendon is grossly oriented in a proximal-distal fashion, it seems logical that the Achilles tendon may be less capable of attenuating forces that occur in the frontal and transverse planes.

| II | **Tendon Structure** Tendinopathy, defined by abnormal ultrasound signal, may precede the experience of pain. Fredberg et al[34] found that 11% of 96 asymptomatic professional soccer players (18-35 years old) showed abnormal ultrasound signal prior to the start of the season. At the end of the season, 45% of the individuals with abnormal ultrasound signal developed a painful Achilles tendinosis, where only 1% of the athletes with normal signal at the start of the season experienced a painful Achilles tendinosis. In a subsequent follow-up study by Fredberg et al[35] of elite soccer players, they calculated a relative risk of 2.8 for developing Achilles tendinosis if abnormal ultrasound signal was identified prior to the start of the season. However, other research has contested these findings. In 1 study, 6 out of 64 athletes reported Achilles tendon pain at the time of the study and none showed an abnormal signal.[132] The differences in exposure to running intensive sports were less in this study compared to the previous 2, which may partially explain the contradictory results. The results of these 3 studies underscore the potential relationship between tendon structure, exposure, and symptoms.

| III | **Comorbidity** Diseases associated with Achilles tendinopathy include obesity, hypertension, increased cholesterol, and diabetes.[43] It has been suggested that these diseases diminish the blood flow that may ultimately reach the Achilles tendon.[43] These disease processes in part explain the prevalence of this disorder in the sedentary population. Interestingly, Achilles tendinopathy has been reported in 6% of cases after taking the antibiotic fluoroquinolone.[11,40] Further, patients who suffer from systemic inflammatory arthritis (eg, rheumatoid arthritis, psoriatic arthritis, and reactive arthritis) may exhibit signs and symptoms consistent with Achilles tendinopathy.[39] However, symptoms and signs in these cohorts are typically confined to the insertion.[104]

EXTRINSIC RISK FACTORS

| II | EXTRINSIC RISK FACTORS THAT HAVE BEEN ASSOCIATED with Achilles tendinopathy include training errors, environmental factors, and faulty equipment. Training errors in runners are cited as a sudden

increase in mileage, an increase in intensity, hill training, returning from a "layoff," or a combination of these factors.[19] As it relates to environmental factors, Milgrom et al[89] compared the influence of training season on the incidence of Achilles tendinopathy in military recruits. The investigators identified a greater number of recruits developed Achilles tendinopathy when training in winter versus summer months. The authors hypothesized the colder temperatures may have increased the friction between the Achilles tendon and paratenon, thereby increasing the likelihood of developing symptoms.[89]

| B | For specific groups of individuals, clinicians should consider abnormal ankle dorsiflexion range of motion, abnormal subtalar joint range of motion, decreased ankle plantar flexion strength, increased foot pronation, and abnormal tendon structure as intrinsic risk factors associated with Achilles tendinopathy. Obesity, hypertension, hyperlipidemia, and diabetes are medical conditions associated with Achilles tendinopathy. Clinicians should also consider training errors, environmental factors, and faulty equipment as extrinsic risk factors associated with Achilles tendinopathy.

DIAGNOSIS/CLASSIFICATION

A THOROUGH HISTORY IN CONJUNCTION WITH A PHYSICAL examination is usually sufficient to arrive at a diagnosis of Achilles tendinopathy.[2,112] There is no accepted classification system for Achilles tendinopathy. Several classification systems have been proposed: Curwin and Stanish proposed a 7-level classification system, based on pain intensity and functional limitation.[22,125] The "Nirschl Pain Phase Scale of Athletic Overuse Injuries" uses a nearly identical 7-phase scale.[96] Puffer and Zachazewski[102] proposed a simpler 4-level scale. However, none of these have been widely accepted or validated for use.

| V | Symptoms are local to the midportion of the Achilles tendon and typically consist of:
• Intermittent pain related to exercises or activity[70]
• Stiffness upon weight bearing after prolonged immobility such as sleeping[62]
• Stiffness and pain at the commencement of an exercise training session that lessens as exercise continues.[62,115] As the condition worsens, a progression from pain felt towards the end of the exercise session to pain throughout the duration of activity occurs.[62] Eventually it may be necessary to suspend exercise.[115]

| II | Signs that have been used in diagnosis include:
• Positive Achilles Tendon Palpation Test. Specifically, local tenderness of the Achilles 2-6 cm proximal to its insertion[71]
• Decreased plantar flexor strength on affected side[69,118]

- Decreased plantar flexor endurance, as demonstrated by a limited ability to perform repetitive unilateral heel raises, when compared to unaffected (or lesser affected) contralateral side[118]
- Arc sign where the area of palpated swelling moves with dorsiflexion and plantar flexion[71]
- Royal London Hospital test. This test is positive when tenderness occurs 3 cm proximal to the calcaneus with the ankle in slight plantar flexion, that decreases as the ankle is dorsiflexed[71]

C Self-reported localized pain and perceived stiffness in the Achilles tendon following a period of inactivity (ie, sleep, prolonged sitting), lessens with an acute bout of activity and may increase after the activity. Symptoms are frequently accompanied with Achilles tendon tenderness, a positive arc sign, and positive findings on the Royal London Hospital test. These signs and symptoms are useful clinical findings for classifying a patient with ankle pain into the ICD category of Achilles bursitis or tendinitis and the associated ICF impairment-based category of Achilles pain (b28015 Pain in lower limb), stiffness (b7800 Sensation of muscle stiffness), and muscle power deficits (b7301 Power of muscles of lower limb).

DIFFERENTIAL DIAGNOSIS

V THE FOLLOWING CONDITIONS SHOULD BE CONSIDERED in the differential diagnosis when a patient with posterior ankle pain presents:
- Acute Achilles tendon rupture[2,109]
- Partial tear of the Achilles tendon[52]
- Retrocalcaneal bursitis[47]
- Posterior ankle impingement[113]
- Irritation or neuroma of the sural nerve[2]
- Os trigonum syndrome[80]
- Accessory soleus muscle[67]
- Achilles tendon ossification[105]
- Systemic inflammatory disease[7]
- Insertional Achilles tendinopathy

F Clinicians should consider diagnostic classifications other than Achilles tendinopathy when the patient's reported activity limitations or impairments of body function and structure are not consistent with those presented in the diagnosis/classification section of this guideline, or, when the patient's symptoms are not resolving with interventions aimed at normalization of the patient's impairments of body function.

IMAGING STUDIES

WHEN A DIAGNOSIS OF ACHILLES TENDINOPATHY IS NOT clear from the history and physical examination, imaging studies are warranted. Ultrasound and magnetic resonance imaging (MRI) are of assistance when clinical exam results are not sufficient to arrive at a diagnosis.[14,70,93] In a prospective head-to-head comparison between ultrasound and MRI that included blinding of examiners to the clinical assessment, which was used as the criterion, their performance in identifying Achilles tendinopathy was similar.[54] Imaging using ultrasound was reported to have a sensitivity of 80%, specificity of 49%, a positive predictive value (PPV) of 65%, and a negative predictive value (NPV) of 68%. Similarly, imaging using MRI was reported to have a sensitivity of 95%, specificity of 50%, positive predictive value of 56%, and negative predictive value of 94%.[54] In this study by Kahn et al,[54] only conservatively treated cases were included, suggesting that this study was more prone to false negative/positive findings. However, given its 3-dimensional capabilities coupled with its ability to display soft tissue, some prefer MRI for visualization of the Achilles tendon.[14] For example, in a prospective study that combined clinical assessment and MRI imaging, sensitivity was 94%, specificity 81%, PPV 90%, NPV 88%, and overall accuracy 89%.[50] However, in this study, a specific MRI sequence was used which is not common. Further, it is likely that both ultrasound and MRI imaging will continue to play an important role in verifying tendon structure to augment clinical decision making.

CLINICAL GUIDELINES
Examination

OUTCOME MEASURES

I THE VICTORIAN INSTITUTE OF SPORT ASSESSMENT (VISA-A) is unique in that it was developed to specifically assess the severity of Achilles tendinopathy.[106] The VISA-A consists of 8 items that assesses stiffness, pain, and function. Acceptable levels of reliability and validity have been reported in published evidence.[106] Specifically, in conservatively managed patients (n = 45) and athletes (n = 24) with Achilles tendinopathy, the VISA-A demonstrated good intrarater ($r = 0.90$) and interrater ($r = 0.90$) reliability, as well as good short-term (1 week) test-retest reliability ($r = 0.81$).[90] Construct validity was established by comparing the VISA-A scores of nonsurgical patients with Achilles tendinopathy (n = 45) to scores on 2 other previously established tendon grading forms and by comparing VISA-A scores of a presurgical group (n = 14) to a control group (n = 87).[90] Additionally, in experimental studies involving those with Achilles tendinopathy the VISA-A has demonstrated sensitivity to change following an intervention.[110,114,120]

I The Foot and Ankle Ability Measure (FAAM) is a region-specific instrument designed to assess activity limitations and participation restrictions for individuals with general musculoskeletal foot and ankle disorders.[81] This includes those with Achilles tendinopathy. It consists of a 21-item Activities of Daily Living (ADL) subscale and separately scored 8-item Sports subscale. The FAAM has strong evidence for content validity, construct validity, test-retest reliability, and responsiveness.[82] Test-retest reliability for the ADL and sports subscales was 0.89 and 0.87, respectively. Likewise, the minimal clinically important difference was reported to be 8 and 9 points for the ADL and sports scales.[82]

A Clinicians should incorporate validated functional outcome measures, such as the Victorian Institute of Sport Assessment and the Foot and Ankle Ability Measure. These should be utilized before and after interventions intended to alleviate the impairments of body function and structure, activity limitations, and participation restrictions associated with Achilles tendinopathy.

ACTIVITY LIMITATION AND PARTICIPATION RESTRICTION MEASURES

II SILBERNAGEL AND COLLEAGUES[120] DEVELOPED A series of 6 tests to assess Achilles tendon function. The set of tests included 3 jump tests, 2 separate strength (heel raise concentric; heel raise eccentric-concentric) tests and a muscular endurance test (repetitive heel raise). Reliability of these tests was established in a group of 15 healthy volunteers (30 ± 2 years). With the exception of the concentric heel raise test (ICC = 0.73), day-to-day reliability was reported as excellent (ICC = 0.76-0.94). In a group of patients (n = 37) with Achilles tendinopathy (symptom duration, 37 ± 67 months) the investigators identified that the series or "test battery" was capable of detecting differences between injured and uninjured (or less injured in the case of bilateral symptoms [12 of the 37 cases]) Achilles tendons. The authors noted that while individual tests (hopping, drop counter movement jump [CMJ], concentric and eccentric-concentric heel raises) were capable of discriminating between affected and either unaffected or lesser affected sides, the test battery was most sensitive if used collectively. Of those tests described in the battery, several are functional measures, including the CMJ, Drop CMJ, and hopping. The results of this work suggest that patients with Achilles tendinopathy demonstrate a decreased capacity to perform activities that include hopping, jumping, and those that require repetitive forceful ankle plantar flexion. Unfortunately, while many of the tests described may be administered in a clinical setting, the methods employed to quantify the data utilized sophisticated laboratory equipment that is not practical in most clinical environments. Whether more simplistic measures of the same tests would yield the same information is unclear and requires additional study.

I The functional measures included in the previously mentioned VISA-A queries the patient's perceived ability to walk, descend stairs, perform unilateral heel raises, single-limb hop, and participate in recreational activity.

B When evaluating functional limitations over an episode of care for those with Achilles tendinopathy, measures of activity limitation and participation restriction can include objective and reproducible assessment of the ability to walk, descend stairs, perform unilateral heel raises, single-limb hop, and participate in recreational activity.

PHYSICAL IMPAIRMENT MEASURES

ANKLE DORSIFLEXION RANGE OF MOTION

ICF category	Measurement of impairment of body function, mobility of a single joint
Description	Passive non–weight-bearing goniometric measure of dorsiflexion with the knee extended to 0° and flexed to 45°. Measures with the knee extended are intended to be descriptive of gastrocnemius flexibility, while those with the knee flexed are thought to reveal soleus flexibility.
Measurement method	The patient assumes a supine position on examination table with ankle and foot suspended over the end of the table for taking the goniometric measure of ankle dorsiflexion with subtalar joint in neutral. The stationary arm of the goniometer is aligned with fibular head. The axis of the goniometer placed just distal to the lateral malleolus and the moveable arm of the goniometer aligned parallel with the plantar aspect of the calcaneus and fifth metatarsal.
Nature of variable	Continuous
Units of measurement	Degrees
Measurement properties	Martin and McPoil[83] published a review of the literature for goniometric ankle measures including dorsiflexion. Most of the identified works in this review reported intratester reliability measures greater than 0.90, while the median interrater reliability was 0.69.[83]

SUBTALAR JOINT RANGE OF MOTION

ICF category	Measurement of impairment of body function, mobility of a single joint.
Description	Passive non–weight-bearing goniometric measure of rearfoot inversion and eversion range of motion.
Measurement method	The stationary arm of the goniometer is held over a bisection of the distal one-third of the tibia and fibula. The axis is placed over the subtalar joint, while the moveable arm is placed over a bisection of the posterior aspect of the calcaneus.
Nature of variable	Continuous
Units of measurement	Degrees
Measurement properties	Intratester and intertester reliability of passive subtalar joint inversion and eversion have been reported in 50 feet from a group of 43 patients (mean age, 35.9 years) with both orthopaedic (37 feet) and neurologic (13 feet) disorders.[29] Intratester reliability (ICC) for inversion without reference to the subtalar joint neutral position for all subjects was 0.74 and 0.79 for those with orthopedic diagnoses. Similarly, eversion values for all subjects were 0.75 and 0.78 for those with orthopaedic diagnoses. Intertester reliability of passive subtalar joint inversion and eversion in this same cohort were poor with values of 0.32 and 0.17.[29] Other research studies, 1 completed using a patient sample[122] and the other examining healthy subjects[131] have identified comparably low interrater reliability values for non–weight-bearing measures of passive inversion (0.28,[131] 0.42[122]) and eversion (0.25,[122] 0.49[131]) range of motion.

PLANTAR FLEXION STRENGTH

ICF category	Measurement of impairment of body function, power of isolated muscles and muscle groups.
Description	Assessment of plantar flexion force production at a controlled speed.
Measurement method	Plantar flexion torque (both average and peak torque) were assessed with an isokinetic dynamometer in 2 positions (sitting with knee flexed to 90° and supine with knee extended to 0°) at 30°/s and 180°/s, using both concentric and eccentric contractions.
Nature of variable	Continuous
Units of measurement	Newton-meters
Measurement properties	Test-retest (5-7 days between tests) reliability coefficients (ICCs) of data obtained from 10 healthy recreationally active subjects between the ages of 31 and 43 (mean age, 37 years) ranged between 0.66 and 0.95 with the knee flexed and between 0.55 and 0.76 with the knee extended.[90]
Instrument variations	Resisted unilateral heel raises with the knee extended using a weight machine has also been described to document

(continued)

PLANTAR FLEXION STRENGTH (CONTINUED)

Instrument variations *(continued)*	strength deficits in this population.[118] Tests have been performed concentrically and in an eccentric-concentric fashion. The reliability (ICC) for the unilateral concentric (0.82) and eccentric-concentric (0.86) heel raise in a healthy population was excellent. Patients with Achilles tendinopathy generate less power (P = .005) on their most symptomatic side (199 ± 122 W) compared to their least symptomatic side (275 ± 128 W) when performing a concentric unilateral heel raise against 33 kg of external resistance. Similar findings were evident for the eccentric-concentric test in the same study. It is appreciated that most clinics do not possess the instrumentation described above and will commonly determine plantar flexor strength based on the number of unilateral heel raises the patient is able to perform. While this method may detect overt plantar flexor weakness, it is a more appropriate measure of endurance and is subsequently described in that section.

PLANTAR FLEXION ENDURANCE

ICF category	Measurement of impairment of body function, endurance of isolated muscles.
Description	Assessment of plantar flexion endurance in weight bearing.
Measurement method	The patient assumes unilateral stance on a level surface, facing either a standard treatment table or wall. The patient is allowed to use fingertips placed either on a treatment table or a wall for balance. The patient performs unilateral heel raises with the knee fully extended through the full available range of motion at a pace of approximately 1 repetition every 2 s, until he or she is unable to complete a full repetition either due to fatigue or pain. Following a rest period of several minutes, the process is repeated on the contralateral side and the numbers of repetitions are compared bilaterally.
Nature of variable	Interval
Units of measurement	Number of repetitions performed.
Measurement properties	Using similar methods, Lunsford and Perry[68] identified a mean of 27.9 repetitions after testing the dominant lower extremity in 203 healthy subjects (122 male; 81 female) of various ages (range, 20-59 years). The reliability of this method was established in both ankles of 10 recreationally active male subjects (mean age, 37 years; range, 31-43 years) free from lower extremity pathology.[90] Retesting was performed by the same examiner at an interval of 5-7 days with identical methodology. On the right side, subjects completed an average of 29.2 ± 5.1 repetitions on the first test session and an average of 30.4 ± 7.4 repetitions on the second session (P = .71; ICC = 0.84). On the left side subjects completed an average of 27.2 ± 5.2 repetitions on the first test session and an average of 28.9 ± 5.1 repetitions on the second session (P = .42; ICC = 0.78). As it relates to the validity of this measure, the number of unilateral heel raises performed was evaluated in a group of 42 patients by Silbernagel and colleagues.[118] On the most symptomatic side the patients performed fewer unilateral heel raises (22 ± 9.9 repetitions) when compared to the least symptomatic side (24 ± 9.1) though this difference was not significant (P = .07). It is worth noting that while a control group was not associated with this comparison, the number of unilateral heel raises performed in the patient sample of this study was less than the number of unilateral heel raises performed in healthy subjects.[90,118]
Instrument variations	Recently, Silbernagel et al[119] examined the total work performed during heel-raises (body weight × total displacement) and found this measure to be more discriminating than the number of heel raises for patients after Achilles tendon repair. When calculating work, the displacement of the body weight during each heel-rise must be quantified.

TRUNCATED ARCH-HEIGHT RATIO

ICF category	Structures related to movement, structure of ankle and foot.
Description	Static partial (50%) weight-bearing descriptor of arch height in relation to truncated foot length.
Measurement method	Heel-to-toe length (HTL) is measured from the posterior, inferior central aspect of the calcaneus to the end of the longest toe. Heel-to-ball length (HBL) is measured from the posterior, inferior central aspect of the calcaneus to the medial aspect of the first metatarsal head. The truncated arch-height ratio is calculated by dividing the dorsal arch height (obtained at 50% of HTL) by HBL. Dorsal arch height is defined as the vertical distance from the floor to the dorsal aspect of the foot at the specified location.
Nature of variable	Continuous
Units of measurement	No units are associated with this measure
Measurement properties	Intrarater reliability for the truncated arch height ratio in 850 healthy subjects was "near perfect" (ICC = 0.98; SEM = 0.03 cm) when the subject stood with equal weight on both feet.[87] Similarly, intertester reliability was excellent (ICC = 0.98; SEM = 0.04 cm) when compared across 3 raters. Validity was established in 12 feet (n = 12) by comparing clinical to radiographic measures. Dorsal arch height (P = .47) and HBL (P = .22) were not significantly different between the 2 methods suggesting the clinical measures are valid.[87]

FOREFOOT ALIGNMENT

ICF category	Structures related to movement, structure of ankle and foot.
Description	Static non–weight-bearing descriptor of frontal plane alignment of the forefoot in relation to the rearfoot with the subtalar joint in neutral.
Measurement method	Prone, with the subtalar joint in neutral. The stationary arm of the goniometer is placed parallel to the plantar aspect of the calcaneus, while the moveable arm is placed in line with the metatarsal heads.
Nature of variable	Continuous
Units of measurement	Degrees
Measurement properties	Correlation coefficients (ICCs) for 2 methods (goniometric and visual estimation) of forefoot alignment as measured by inexperienced (2 physical therapy students) and experienced (2 physical therapists with 10 or more years of experience) raters in a group of 10 subjects (5 male, 5 female) with no history of lower extremity pathology have been reported.[123] For the goniometric method, intratester reliability ($ICC_{2,1}$) ranged from 0.08 to 0.78 in experienced raters and from 0.16 to 0.65 in inexperienced raters. For the visual estimation method, intratester reliability ($ICC_{2,1}$) ranged from 0.51 to 0.76 in experienced raters and from 0.53 to 0.57 in the inexperienced raters. Intertester reliability ($ICC_{2,2}$) for the goniometric method was 0.38 and 0.42 for experienced and inexperienced raters respectively. Intertester reliability ($ICC_{2,2}$) for the visual estimation method was 0.81 and 0.72 for experienced and inexperienced raters respectively.[123] A more recent study using the goniometric method to quantify forefoot alignment in a larger group (n = 30, 60 feet) of adult (age, 35.6 years) subjects revealed good intrarater reliability among 4 raters with ICC values ranging between 0.77 and 0.90.[30] Interrater reliability for the same study was considered moderate (ICC = 0.70).[30]

ACHILLES TENDON PALPATION TEST

ICF category	Measurement of impairment of body function, pain in body part
Description	The patient is positioned prone on an examination table with the ankles hanging just over the edge of the table. Gentle palpation of the entire Achilles tendon is performed by squeezing the tendon between thumb and index fingers.
Measurement method	The patient is asked to indicate whether pain was present or absent with palpation.
Nature of variable	Dichotomous
Units of measurement	N/A
Measurement properties	A group of 10 male athletes (28.5 ± 6.8 y) with confirmed unilateral Achilles tendinopathy were evaluated by 3 expert raters and then compared to a group of 14 healthy controls (27.1 ± 7.4 y). The palpation test was reported to have a sensitivity of 0.58 and specificity of 0.84. Kappa values for intratester reliability were reported between 0.27 to 0.72, while kappa values for intertester reliability have been reported between 0.72 and 0.85.[71]

ARC SIGN

ICF category	Measurement of impairment of body function, pain in body part
Description	The patient is positioned prone on an examination table with the ankles hanging relaxed just over the edge of the table. The patient is asked to actively plantar flex and dorsiflex the ankles.
Measurement method	Examiners are instructed to determine if the area of maximal localized swelling moves proximal and distal with the tendon during active range of motion or remains static. If the identified area moves proximal and distal, the result is classified as "tendinopathy present." Conversely, if the area remains static, the result is classified as "tendinopathy absent."
Nature of variable	Dichotomous
Units of measurement	N/A
Measurement properties	When a group of 10 male athletes (28.5 ± 6.8 y) with confirmed unilateral Achilles tendinopathy were evaluated by 3 expert raters and then compared to a group of 14 healthy controls (27.1 ± 7.4 y), the arc sign was reported to have a sensitivity of 0.52 and specificity of 0.83. Kappa values for intratester reliability were reported between 0.28 to 0.75, while kappa values for intertester reliability have been reported between 0.55 and 0.72.[71]

ROYAL LONDON TEST	
ICF category	Measurement of impairment of body function, pain in body part
Description	The patient is positioned prone on an examination table, with the ankles hanging relaxed just over the edge of the table. In this position, the examiner identifies the portion of the Achilles tendon which is maximally tender to palpation. The patient is then asked to actively dorsiflex the ankle. The examiner once again palpates the part of the tendon that was identified as maximally tender, however, this time in maximal dorsiflexion. Patients with Achilles tendinopathy often report a substantial decrease or absence of pain when the palpation technique is repeated in dorsiflexion.
Measurement method	With the ankle in maximal active dorsiflexion, the examiner classifies the identified area with palpation as "tenderness present" or "tenderness absent."
Nature of variable	Dichotomous
Units of measurement	N/A
Measurement properties	When a group of 10 male athletes (28.5 ± 6.8 y) with confirmed unilateral Achilles tendinopathy were evaluated by 3 expert raters and then compared to a group of 14 healthy controls (27.1 ± 7.4 y), the Royal London Test was reported to have a sensitivity of 0.54 and specificity of 0.91. Kappa values for intratester reliability were reported between 0.60 to 0.89, while kappa values for intertester reliability have been reported between 0.63 and 0.76.[71]

PROGNOSIS

THE LONG-TERM PROGNOSIS FOR PATIENTS WITH ACUTE-to-subchronic Achilles tendinopathy is favorable with nonoperative treatment.[2,98] Significant decreases in pain and improvement in function have been reported following 6 to 12 weeks of intervention.[5,111] Long-term follow-up ranging between 2 and 8 years suggests that between 71% to 100% of patients with Achilles tendinopathy are able to return to their prior level of activity with minimal or no complaints.[3,97,98] Interestingly, the results of both conservative[114] and operative care[74] are less favorable in nonathletic populations.

Conservative therapy is initially recommended for those with Achilles tendinopathy. When conservative treatment fails, surgery is recommended to remove fibrotic adhesions and degenerative nodules to restore vascularity.[109]

Paavola et al[98] found in their 8-year follow-up study that 29% of those with acute to subacute Achilles tendinopathy required surgical intervention.[98] Those that did undergo surgery had favorable outcomes with postoperative treatment.

Retrospective studies have reported surgical rates for those failing conservative treatment ranging from 24% to 49%.[46,60,65] Those patients who responded to nonoperative therapy tended to be younger (average age, 33 years) than those requiring surgery (average age, 48 years).[46] Four to 6 months of conservative intervention is recommended for those with Achilles tendinopathy.[46]

CLINICAL GUIDELINES
Interventions

Numerous interventions have been employed by practitioners for the treatment of Achilles tendinopathy. Varying levels of success and evidence are available for each of these interventions as outlined below. While the purpose of this guideline is to focus on interventions within the scope of physical therapy practice, other interventions have been studied.[2,78,103,109,115,124] These include extracorporeal shockwave therapy, where there has been some conflicting evidence reported,[20,110] local steroid injection, where there has been conflicting evidence reported,[23,36] sclerosing injection, where there has been conflicting evidence reported,[4,15] and oral nonsteroidal anti-inflammatory medications, where there has been no evidence reported.[109]

ECCENTRIC LOADING

THE USE OF ECCENTRIC EXERCISE IN THE TREATMENT OF Achilles tendinopathy has received considerable attention. There are 3 studies with level I evidence[108,110,120] and 11 studies with level II evidence.[5,25,31,56,75,77,97,111,114,117,121] Although these studies generally note good outcomes with athletic individuals who have midportion Achilles tendinopathy, it is reported that nonathletic individuals[75,114] and those with insertional Achilles tendinopathy[31] do not seem to respond as favorably. Curwin and Stanish[22] developed the eccentric program in the early 1980s. Their program consisted of 3 sets of 10 repetitions of progressive eccentric loading, titrated by pain occurring between repetitions 20 and 30, and increased weekly. Load was increased weekly, while speed of movement was changed daily. They reported, in a series of 75 patients with Achilles tendinopathy, that 95% of patients had symptom resolution within 6 to 8 weeks.[126] Alfredson et al[5] modified the eccentric loading program to consist of unilateral eccentric heel raises with no concentric component removing the gradual progression originally described. The unaffected contralateral lower extremity returns the affected ankle to the starting position. Movements are to be slow and controlled with moderate but not disabling pain. Exercises consisting of 3 sets of 15 repetitions, both with the knee extended and flexed, are to be performed twice daily for 12 weeks. Subjects are to add external resistance via a back pack if the exercise becomes too easy. If a greater amount of external resistance is necessary, subjects are to use a weight machine.[5] This eccentric training may be beneficial because of its effect on improving microcirculation[56] and peritendinous type I collagen synthesis.[55] There is considerable variability in the way eccentric exercise are performed, and it is not currently known which protocol is most effective.[88]

I Studies have specifically shown a decrease in pain[108,110,121] and improved VISA-A scores,[108,110] with an eccentric training program for those with midportion Achilles tendinopathy. Although Silbernagel et al[121] found a significant decrease in pain at 1-year follow-up, performance with jumping and toe raising did not improve with the eccentric program when compared to a control group. The eccentric program was found to be superior to low-energy shock wave treatment[110]; however, extracorporeal shockwave therapy (ESWT) combined with the eccentric program was better than eccentric exercises alone.[108]

II Additional studies have also noted an eccentric training program for those with midportion Achilles tendinopathy to decrease pain,[5,31,56,77,111,117] improve function,[111] improve VISA-A scores,[25,75,120] and increase strength.[5] Concentric exercises do not seem to have the same effect as an eccentric program.[77] Investigation employing eccentric exercise has also shown localized decreases in tendon thickness and normalized tendon structure.[97]

A Clinicians should consider implementing an eccentric loading program to decrease pain and improve function in patients with midportion Achilles tendinopathy.

LASER THERAPY

I A RECENT SYSTEMATIC REVIEW WITH META-ANALysis in which low-level laser therapy (LLLT) was used to treat nonregional specific tendinopathy revealed favorable outcomes when treatment parameters recommended by the World Association of Laser Therapy (WALT) were followed.[130] Few studies, however, have overtly examined the influence of LLLT in human subjects with Achilles tendinopathy.[12,127] LLLT enhanced outcomes in a group of 20 subjects (12 male, 8 female), when coupled with eccentric exercises, compared to 20 subjects (13 male, 7 female) in an eccentric exercise group who received placebo laser treatment.[127] There were no statistical differences in age, height, weight, symptom duration, or quantity of active ankle dorsiflexion between the randomly assigned groups. Treatment was administered for 12 sessions over 8 weeks in a blinded fashion. Six points along the painful Achilles tendon were irradiated. All laser sessions were performed by the same physical therapist. Laser parameters included an 820 nm wavelength with an energy of 0.9 J per point. While there

were no differences in perceived pain (100-mm visual analog scale) at baseline between placebo (81.8 ± 11.6) and intervention groups (79.8 ± 9.5), a significant (*P*<.01) difference between groups was reported at 4, 8, and 12 weeks. Specifically, the intervention group perceived less pain with differences of 17.9, 33.6, and 20 mm between groups at 4, 8, and 12 weeks respectively. Improvements in the intervention group were also noted in secondary measures, including tenderness to palpation, crepitation, morning stiffness, and active dorsiflexion range of motion.[127] An additional study in 7 patients with bilateral Achilles tendinopathy yielded positive results when examining the influence of LLLT.[12] Using a 904-nm probe, at 5.4 J per point, Bjordal and colleagues,[12] identified that LLLT can reduce pain and inflammation associated with an acute (exercise induced) exacerbation of Achilles tendonitis. Based on these limited works, the future of LLLT is promising for patients suffering from Achilles tendon pain. Given the limited number of studies employing LLLT in this population, additional study is warranted.

B Clinicians should consider the use of low-level laser therapy to decrease pain and stiffness in patients with Achilles tendinopathy.

IONTOPHORESIS

II IN A DOUBLE-BLIND STUDY, NEETER AND COLleagues[92] evaluated the influence of iontophoresis in 25 patients with Achilles tendon symptoms of less than 3 months' duration. Patients were randomly assigned to either experimental or control groups. The experimental group consisted of 14 subjects (5 female, 9 male) with a mean age of 38.0 ± 15.6 years, while the control group consisted of 11 subjects (5 female, 6 male) with a mean age of 39.0 ± 3.9 years. Over the course of 2 weeks, patients received 4 treatments of iontophoresis either with 3 ml of dexamethasone or saline solution for approximately 20 minutes (neither the intensity of iontophoresis nor concentration of dexamethasone was reported). Following the iontophoresis treatments, both groups followed the same rehabilitation program for 10 weeks. Dependent measures were assessed at 2 weeks, 6 weeks, 3 months, 6 months, and 1 year. While there were no differences between groups in the ability to perform repeated unilateral heel raises, in ankle dorsiflexion or plantar flexion range of motion, or morning stiffness at any of the assessment intervals, significant improvements were observed in several dependent measures in the experimental group over the course of the study. At 6 weeks (and again at 6 and 12 months), the experimental group reported less pain during walking compared to before treatment. At 6 and 12 months, the experimental group reported less pain postphysical activity and while ascending and descending stairs, when compared to the control group. Both groups noted improvements

in Achilles tendon pain during activity over the course of the study.[92] While the majority of differences between groups were observed at the 6-month assessment interval and iontophoresis was only administered 4 sessions at the beginning of the study, the strength of the inherent design suggests iontophoresis with dexamethasone is of benefit for patients with Achilles tendinopathy. Additional studies incorporating the use of iontophoresis are warranted.

B Clinicians should consider the use of iontophoresis with dexamethasone to decrease pain and improve function in patients with Achilles tendinopathy.

STRETCHING

STRETCHING HAS ANECDOTALLY BEEN RECOMMENDED AS an intervention for patients with Achilles tendinopathy. Surprisingly, little evidence supporting stretching to prevent or as an effective intervention for Achilles tendinopathy is available.[99]

II Only 1 study was identified that examined the influence of stretching as an isolated intervention.[94] Forty-five subjects with Achilles tendon pain of at least 3 months' duration were randomly assigned to either an eccentric loading program or a calf-stretching program. At the onset of the study, the authors reported no statistical difference between groups related to age, male/female distribution, number of subjects with bilateral symptoms, or duration of symptoms. The interventions were performed for a 12-week period. Follow- up measures (tendon tenderness, ultrasonographic measures of tendon thickness, self-reported symptoms, and the patient's global self-assessment) were evaluated at 3, 6, 9, 12, and 52 weeks. The self-report outcome measure was described as a modification of the knee osteoarthritis outcome score (KOOS) for the ankle. Reliability and validity of the modified questionnaire was not reported. The global assessment asked the subjects to choose among 1 of 8 categories related to symptom behavior (eg, levels of worsening symptoms, improvement, or no change). Over the course of the study, several subjects were excluded, largely due to noncompliance. The authors reported 38 of the 45 randomized subjects were followed for at least 3 months. While it was unclear exactly how many subjects were ultimately in each group, the authors reported that 21 and 23 tendons were evaluated at 3 and 12 months in the eccentric group. Similarly, 24 and 19 tendons were evaluated at 3 and 12 months in the stretching group. Both groups gradually improved though no differences were noted between groups.[94] As there was not a control group, it is unclear as to whether or not subjects improved because of the intervention, the passage of time, or a combination of both. Common sense suggests patients with limited dorsiflexion and Achilles tendinopathy may benefit

most from a calf-stretching program in hopes of alleviating symptoms. Unfortunately, we did not identify evidence in this regard. Additional study, including a control group and measures of dorsiflexion range of motion in conjunction with the appropriate self-report outcome measures, would be valuable contributions to the existing literature.

C Stretching exercises can be used to reduce pain and improve function in patients who exhibit limited dorsiflexion range of motion with Achilles tendinopathy.

FOOT ORTHOSES

As increased pronation has been associated with Achilles tendinopathy,[19,60,86] it seems logical to incorporate the use of a foot orthosis as a component of the overall intervention program in those subjects who exhibit increased pronation. However, only limited evidence exists to support the use of foot orthoses in this population.

II Mayer and colleagues[85] conducted a 4-week study in which they randomly assigned runners with unilateral Achilles tendinopathy to 1 of 3 groups: (1) custom semi-rigid inserts (n = 9), (2) physical therapy intervention (n = 11), or (3) to a control group (n = 8). Subjects in each group were similar in age (inserts, 35 ± 6.7 years; physical therapy, 41 ± 5.9 years; control, 38 ± 4.9 years), height, weight, as well as kilometers run per week (inserts, 50 ± 13.5; physical therapy, 50 ± 13.6; control, 53.1 ± 10.6). Subjects in the inserts group had a custom insert that was prescribed and fitted by the same technician. Subjects were instructed to wear the inserts for all physical activities during the 4-week intervention phase. Subjects in the physical therapy group received 10 physical therapy sessions over a 4-week period. Treatment consisted of ice, pulsed ultrasound, deep friction massage, and therapeutic exercise and activities. Dependent measures included pain level and isokinetic plantar flexion torque (concentric and eccentric). Significant improvements (>10%) in eccentric plantar flexion torque were apparent in both intervention groups after 4 weeks. No differences (<10%), however, were noted between groups with concentric plantar flexion torque. Both intervention groups reported pain decreased to less than 50% of the baseline measures after 4 weeks.

II A more recent biomechanical study utilizing 3-dimensional kinematic analysis compared the effect of custom orthoses in a group of runners suffering from mild Achilles tendinopathy (n = 12) to a group of control subjects (n = 12).[27] Each group consisted of 1 female and 11 male participants. Subjects in the control group were similar in age (38.7 ± 8.1 years), height (1.75 ± 0.05 m), and weight (73.3 ± 8.5 kg), when compared to the symptomatic

group (age, 44.3 ± 8.4 years; height, 1.78 ± 0.05 m; weight, 79.3 ± 12.2 kg). Subjects in the symptomatic group were prescreened by the same clinician and qualitatively exhibited signs of increased pronation. Subjects with a pes cavus foot structure despite having Achilles tendinopathy were excluded from the symptomatic group. Without orthotics, the group with Achilles tendinopathy exhibited kinematic differences that included a more inverted calcaneal position at heel strike and increased peak calcaneal eversion, ankle dorsiflexion, and knee flexion during stance, when compared to the control group. These results are consistent with those previously described by McCrory et al.[86] Amongst subjects with Achilles tendinopathy, when no-orthotic and orthotic conditions were compared, subjects displayed less ankle dorsiflexion but exhibited an increase in calcaneal eversion when using the orthotic device.[27] Though an increase in calcaneal eversion with the orthotics was a counterintuitive finding, it illustrates the complexity of human locomotion. While unknown, it is possible that without an orthotic device designed to limit excessive pronation, subjects with Achilles tendinopathy subconsciously maintained their foot in greater amounts of supination to prevent the potential deleterious effects of excessive pronation on the soft tissue. With an orthotic device designed to limit pronation, subjects might have then allowed their foot to proceed through pronation as excessive movement was restricted by the orthotic device. If true, this logic would explain why increased pronation may have been observed during the orthotic condition in this study.

III An additional study identified that runners experienced a decrease in symptoms with the use of orthotic inserts for a variety of lower extremity orthopedic diagnoses, including Achilles tendinopathy.[41]

C A foot orthosis can be used to reduce pain and alter ankle and foot kinematics while running in patients with Achilles tendinopathy.

MANUAL THERAPY

IV A single case study utilizing an ABA design evaluated the effectiveness of a treatment protocol of accessory and combined specific soft tissue mobilization (STM) in a 39-year-old female with a 5-year history of Achilles tendinosis.[18] The study involved 3 six-week phases (preintervention, intervention, and postintervention) and a follow-up 3-month evaluation. The preintervention phase consisted of obtaining baseline measures for all dependent variables (pain, dorsiflexion range of motion, and a self-report outcome measure [VISA-A]) once a week. The intervention phase initially consisted of "accessory" STM to the Achilles tendon with the gastrocnemius-soleus complex on slack. Specifically, this STM procedure consisted of glid-

ing the Achilles tendon in a direction in which it was deemed hypomobile (in this case study the direction was medially). The STM was progressed such that the gastrocnemius-soleus complex was placed on stretch and ultimately performed, while the patient was performing non–weight-bearing concentric and eccentric contractions versus resistance with an elastic band. When the STM was performed in conjunction with either a stretch or muscular contraction, it was described as "combined" STM. Following intervention, substantial improvements in all dependent measures were observed. Specifically, pain was reported as a 0/10, dorsiflexion range of motion both with the knee flexed and extended increased significantly, and a 100% score (indicating no limitations) on the VISA-A was recorded.[18] Further contributions to the evidence could include investigating the interventions used in this case study using a larger sample and an experimental design.

| F | Soft tissue mobilization can be used to reduce pain, and improve mobility and function in patients with Achilles tendinopathy. |

TAPING

| V | Taping techniques to alleviate pain and improve function in patients with Achilles tendinopathy have long been used by clinicians. We |
were unable, however, to locate any published studies that examined the efficacy of taping in this population. Common techniques that have been suggested by clinicians include the "off-loading" and "equinus constraint" methods.[84] The off-loading method attempts to directly limit longitudinal strain on the Achilles tendon, while the equinus constraint is designed to limit dorsiflexion range of motion and hence longitudinal strain on the Achilles tendon. As patients with Achilles tendinopathy frequently exhibit signs of increased pronation, other taping techniques (eg, low-Dye arch taping) aimed at limiting pronation may be effective in the short term of alleviating pain and improving function in this population. However, until formal research studies are completed in this regard, the effectiveness of taping in this population is largely unknown and based primarily on expert opinion.

| F | Taping may be used in an attempt to decrease strain on the Achilles tendon in patients with Achilles tendinopathy |

HEEL LIFTS

| II | The use of a heel lift on a temporary basis is commonly recommended to reduce stress on the Achilles tendon by putting proximal calf musculature and Achilles tendon itself on slack. Classically, heel |

lifts of 12 to 15 mm have been advocated.[19] In individuals without pathology, heel lifts needed to be between 1.9 to 5.7 cm to decrease gastrocnemius muscle activity during level walking.[64]

| I | Lowdon and colleagues[66] randomly assigned 33 subjects with Achilles tendonitis to 1 of 3 groups. Group 1 consisted of 11 subjects (7 males, 4 females; |
age, 26 years) and were issued a commercially available viscoelastic insert of undisclosed height. Group 2 consisted of 10 subjects (7 males, 3 females; age, 27 years) and were issued compressible rubber pads 15 mm in height when uncompressed. Group 3 was comprised of 12 subjects (6 males, 6 females; age, 30 years) who served as controls. Next, each group received an identical intervention which included 5 pulsed ultrasound sessions and instruction in stretching and strengthening the calf musculature. Specific details of these activities were not disclosed. Dependent measures including perceived pain, swelling and tenderness, activity level, the magnitude of forces at heel strike and toe-off as quantified by a force plate, as well as stance duration, were assessed at baseline, 10 days, and after 2 months. Despite random allocation, a significant difference in symptom duration existed between the groups, with group 3 being shorter in height when compared to groups 1 and 2. This finding made comparisons of group 3 to groups 1 and 2 of minimal importance. No differences in gait parameters were observed for subjects in group 1. A significant ($P<.05$) decrease in stance duration from 629 ± 39 milliseconds to 599 ± 56 milliseconds of the affected lower extremity was noted in group 2. The authors interpreted this finding as the ability of the subjects to ambulate with an increase in cadence. Otherwise, subjects in group 2 generally had a more favorable response with respect to pain, swelling and tenderness, and ability to participate in activity when compared to group 1.

| IV | A case series of 14 consecutive athletes (mean age, 30.6 years; range, 13-46 years; 9 males, 5 females) with Achilles tendonitis (symptom duration, 1 |
week-10 years) that received a pair of viscoelastic heel lifts was identified.[69] The athletes were competing in a wide range of sports at various levels of activity. The authors reported that after 3 months of wearing the viscoelastic lifts, all but 1 patient had returned to unrestricted pain-free activity. Further, the authors reported half of the patients failed to improve with other forms of intervention including local modalities, physiotherapy, and casting. While the results from this report describe the potential benefits of viscoelastic heel inserts for patients with Achilles tendonitis, the scientific value of the report is limited. Specifically, the authors did not report the height of the insert, a control group was not utilized, and discrimination between disorders of the paratenon and tendon was not performed.

V Though the literature offers only minimal evidence for the use of heel lifts for patients with symptoms of Achilles tendinopathy, the use of a rigid lift, 12 mm in height, on a temporary basis to alleviate symptoms associated with this disorder could be a simple, cost effective, and potentially beneficial intervention. Additional studies in the future will assist in determining the efficacy of heel lifts in management of Achilles tendinopathy.

D Contradictory evidence exists for the use of heel lifts in patients with Achilles tendinopathy.

NIGHT SPLINTS

II Two STUDIES WERE IDENTIFIED THAT INVESTIGATED the efficacy of a night splint in patients with Achilles tendinopathy.[26,111] Of these, only 1 examined the influence of a night splint alone on the symptoms and function of subjects.[111] Specifically, Roos and colleagues[111] randomly assigned 44 subjects with Achilles tendinopathy (mean age, 45 years; 23 female, 22 male participants) to 1 of 3 groups: (1) eccentric exercise, (2) night splint, or (3) both eccentric exercise and a night splint for 12 weeks. Dependent measures (pain, self-report outcome score [Foot and Ankle Outcome Score]) were captured at 0, 6, 12, 26, and 52 weeks. At 12 weeks, the eccentric group reported less pain ($P = .04$) when compared to the night splint only group. Also at this timeframe, a greater number of subjects in the eccentric exercise only group were able to return to sport activity when compared to the splint only group. Results from this work suggest that a night splint is inferior when compared to an eccentric training program. Supporting this, further study has found no additional value of a night splint when coupled with an eccentric training program.[26]

C Night splints are not beneficial in reducing pain, when compared to eccentric exercise, in patients with Achilles tendinopathy.

CLINICAL GUIDELINES

Summary of Recommendations

B RISK FACTORS

For specific groups of individuals, clinicians should consider abnormal ankle dorsiflexion range of motion, abnormal subtalar joint range of motion, decreased ankle plantar flexion strength, increased foot pronation, and abnormal tendon structure as intrinsic risk factors associated with Achilles tendinopathy. Obesity, hypertension, hyperlipidemia, and diabetes are medical conditions associated with Achilles tendinopathy. Clinicians should also consider training errors, environmental factors, and faulty equipment as extrinsic risk factors associated with Achilles tendinopathy.

C DIAGNOSIS/CLASSIFICATION

Self-reported localized pain and perceived stiffness in the Achilles tendon following a period of inactivity (ie, sleep, prolonged sitting), lessens with an acute bout of activity and may increase after the activity. Symptoms are frequently accompanied with Achilles tendon tenderness, a positive arc sign, and positive findings on the Royal London Hospital test. These signs and symptoms are useful clinical findings for classifying a patient with ankle pain into the ICD category of Achilles bursitis or tendinitis and the associated ICF impairment-based category of Achilles pain (b28015 Pain in lower limb), stiffness (b7800 Sensation of muscle stiffness), and muscle power deficits (b7301 Power of muscles of lower limb).

F DIFFERENTIAL DIAGNOSIS

Clinicians should consider diagnostic classifications other than Achilles tendinopathy when the patient's reported activity limitations or impairments of body function and structure are not consistent with those presented in the diagnosis/classification section of this guideline, or, when the patient's symptoms are not resolving with interventions aimed at normalization of the patient's impairments of body function.

A EXAMINATION – OUTCOME MEASURES

Clinicians should incorporate validated functional outcome measures, such as the Victorian Institute of Sport Assessment and the Foot and Ankle Ability Measure. These should be utilized before and after interventions intended to alleviate the impairments of body function and structure, activity limitations, and participation restrictions associated with Achilles tendinopathy.

B EXAMINATION – ACTIVITY LIMITATION AND PARTICIPATION RESTRICTION MEASURES

When evaluating functional limitations over an episode of care for those with Achilles tendinopathy, measures of activity limitation and participation restriction can include objective and reproducible assessment of the ability to walk, descend stairs, perform unilateral heel raises, single-limb hop, and participate in recreational activity.

B EXAMINATION – PHYSICAL IMPAIRMENT MEASURES

When evaluating physical impairment over an episode of care for those with Achilles tendinopathy, one should consider measuring dorsiflexion range of motion, subtalar joint range of motion, plantar flexion strength and endurance, static arch height, forefoot alignment, and pain with palpation.

A INTERVENTIONS – ECCENTRIC LOADING

Clinicians should consider implementing an eccentric loading program to decrease pain and improve function in patients with midportion Achilles tendinopathy.

B INTERVENTIONS – LOW-LEVEL LASER THERAPY

Clinicians should consider the use of low-level laser therapy to decrease pain and stiffness in patients with Achilles tendinopathy.

B INTERVENTIONS – IONTOPHORESIS

Clinicians should consider the use of iontophoresis with dexamethasone to decrease pain and improve function in patients with Achilles tendinopathy.

C INTERVENTIONS – STRETCHING

Stretching exercises can be used to reduce pain and improve function in patients who exhibit limited dorsiflexion range of motion with Achilles tendinopathy.

C INTERVENTIONS – FOOT ORTHOSES

A foot orthosis can be used to reduce pain and alter ankle and foot kinematics while running in patients with Achilles tendinopathy.

F INTERVENTIONS – MANUAL THERAPY

Soft tissue mobilization can be used to reduce pain and improve mobility and function in patients with Achilles tendinopathy.

F INTERVENTIONS – TAPING

Taping may be used in an attempt to decrease strain on the Achilles tendon in patients with Achilles tendinopathy.

D INTERVENTIONS – HEEL LIFTS

Contradictory evidence exists for the use of heel lifts in patients with Achilles tendinopathy.

C INTERVENTIONS – NIGHT SPLINTS

Night splints are not beneficial in reducing pain when compared to eccentric exercise for patients with Achilles tendinopathy.

AFFILIATIONS AND CONTACTS

AUTHORS

Christopher R. Carcia, PT, PhD
Associate Professor
Department of Physical Therapy
Director, PhD program in Rehabilitation Science
Duquesne University
Pittsburgh, PA
carcia@duq.edu

RobRoy L. Martin, PT, PhD
Associate Professor
Department of Physical Therapy
Duquesne University
Pittsburgh, PA
Staff Physical Therapist
Center for Rehab Services
University of Pittsburgh Medical Center
Pittsburgh, PA
martinr280@duq.edu

Jeff Houck, PT, PhD
Associate Professor
Department of Physical Therapy
Ithaca University
Rochester, NY
jhouck@ithaca.edu

Dane K. Wukich, MD
Chief, Division of Foot and Ankle Surgery
Assistant Professor of Orthopaedic Surgery
University of Pittsburgh Comprehensive Foot and Ankle Center
Pittsburgh, PA
wukichdk@upmc.edu

REVIEWERS

Roy D. Altman, MD
Professor of Medicine
Division of Rheumatology and Immunology
David Geffen School of Medicine at UCLA
Los Angeles, CA
journals@royaltman.com

Sandra Curwin, BSc(Physio), PhD
Associate Professor
School of Physiotherapy
Dalhousie University
Halifax, NS, Canada
Sandra.Curwin@dal.ca

Anthony Delitto, PT, PhD
Professor and Chair
School of Health & Rehabilitation Sciences
University of Pittsburgh
Pittsburgh, PA
delitto@pitt.edu

John DeWitt, DPT
Director of Physical Therapy Sports & Orthopaedic Residencies
The Ohio State University
Columbus, OH
john.dewitt@osumc.edu

Helene Fearon, PT
Principal and Consultant
Fearon/Levine Consulting
Phoenix, AZ
helenefearon@fearonlevine.com

Amanda Ferland, DPT
Clinic Director
MVP Physical Therapy
Federal Way, WA
aferland@mvppt.com

Joy MacDermid, PT, PhD
Associate Professor
School of Rehabilitation Science
McMaster University
Hamilton, Ontario, Canada
macderj@mcmaster.ca

James W. Matheson, DPT
Larsen Sports Medicine and Physical Therapy
Hudson, WI
jw@eipconsulting.com

Philip McClure, PT, PhD
Professor
Department of Physical Therapy
Arcadia University
Glenside, PA
mcclure@arcadia.edu

Thomas G. McPoil, PT, PhD
Professor
School of Physical Therapy
Regis University
Denver, CO
tommcpoil@gmail.com

Stephen Reischl, DPT
Adjunct Associate Professor of Clinical Physical Therapy
Division of Biokinesiology and Physical Therapy at Herman Ostrow School of Dentistry
University of Southern California
Los Angeles, CA
reischl@usc.edu

Paul Shekelle, MD, PhD
Director
Southern California Evidenced-Based Practice Center
Rand Corporation
Santa Monica, CA
shekelle@rand.org

A. Russell Smith, Jr, PT, EdD
Chair
Clinical & Applied Movement Sciences
University of North Florida
Jacksonville, FL
arsmith@unf.edu

Leslie Torburn, DPT
Principal and Consultant
Silhouette Consulting, Inc.
Redwood City, CA
torburn@yahoo.com

James Zachazewski, DPT
Clinical Director
Department of Physical and Occupational Therapy
Massachusetts General Hospital
Boston, MA
jzachazewski@partners.org

COORDINATOR

Joseph Godges, DPT
ICF Practice Guidelines Coordinator
Orthopaedic Section, APTA Inc
La Crosse, WI
icf@orthopt.org

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