

Functional Asymmetries are Small and Varied in Achilles Tendinopathy: Implications for Clinical Assessment

Stanton Godshall¹, Devyn Russo¹, Andy K. Smith², Ryan T. Pohl², Karin Grävare Silbernagel², Josh R. Baxter¹

¹University of Pennsylvania, Philadelphia, PA, ²University of Delaware, Newark, DE

stanton.godshall@penmedicine.upenn.edu

DISCLOSURES: Stanton Godshall (N), Devyn Russo (N), Andy K. Smith (N), Ryan T. Pohl (N), Karin Grävare Silbernagel (N), Josh R. Baxter (N)

INTRODUCTION: The Achilles tendon is the strongest and largest tendon in the body and is responsible for transmitting forces up to 7.3 times bodyweight to facilitate locomotion [1,2]. Given this biomechanical role, injury to the Achilles tendon, like tendinopathy, is expected to impair plantar flexor function. Achilles tendinopathy is a painful and debilitating condition that is defined by localized pain and loss of function [3]. Several studies have shown that functional deficits, like strength and endurance, are present between limbs in Achilles tendinopathy patients [4,5]. Addressing functional deficits is often considered necessary for full recovery of tendon health. However, increasingly, studies show that between limb functional deficits are not as clear cut as originally understood. Several studies have found small or no differences between limbs in Achilles tendinopathy patients [6,7]. Thus, our objective was to assess functional asymmetries across a battery of functional tests to contribute to the ongoing study of between-limb functional deficits in Achilles tendinopathy. Our hypothesis was that patients would exhibit reduced performance across functional tests on their most symptomatic limb.

METHODS: We recruited 39 patients (20 female, age 47.7±11.4, BMI 28.6±6.1) to complete a functional test-battery in this IRB-approved study. Patients completed unilateral maximum voluntary contractions on an isokinetic dynamometer at three speeds (isometric, 30°/s, 150°/s) to capture a comprehensive range of ankle function. Additionally, clinically relevant task-based assessments were completed as patients did unilateral heel-rise and countermovement jump tests [4]. Patient surveys and ultrasound measurements were taken to contextualize functional asymmetries. We compared performance between the most and least symptomatic limb with paired t-tests when the underlying distribution was approximately normal, and used Wilcoxon ranked sign test elsewhere. Percent difference between limbs was calculated for each person to describe asymmetry patterns.

RESULTS: The most symptomatic limb showed statistically significant deficits in four out of five functional tests (**Figure 1**). Statistically significant between-limb differences include isometric torque (p=0.027), 30°/s isokinetic torque (p=0.002), 150°/s isokinetic torque (p=0.019), and calf raise fatigue work (p=0.032), with all tests having small-to-moderate effect sizes (0.342-0.523). The median between-limb percent difference ranged from -0.20% to 12.63% across the test battery (**Figure 2**). Notably, several patients exhibited asymmetries greater than 10% where the most symptomatic limb outperformed the least symptomatic limb: 9 during isometric testing, 5 during 30°/s isokinetic testing, 8 during 150°/s isokinetic testing, 7 during calf raise fatigue testing, and 3 during countermovement jump testing.

DISCUSSION: Our study partially confirmed the hypothesis that the most symptomatic limb would show reduced functional performance relative to the least symptomatic limb. Significant between-limb differences emerged in highly constrained plantar flexion torque tasks and calf raise fatigue tests. However, no group-level differences were found in countermovement jump performance, likely due to its multi-joint, skill-dependent nature. Effect sizes were modest, and individual variability was high. When we considered percent difference across tests, we found that several patients performed better on their most symptomatic limb, challenging the assumption that between-limb deficits are present in all individuals with Achilles tendinopathy. This may be due to subclinical bilateral symptoms, even when pain is unilateral. Exploratory analysis identified VISA-A score as the strongest predictor of asymmetry, while other factors like bilateral symptoms or tendon thickness asymmetry had minimal impact. A key limitation is the inclusion of patients with bilateral symptoms, which may reduce asymmetries. This was done to reflect real-world clinical populations. Additionally, patients who declined participation in certain tasks due to anticipated pain were excluded, likely biasing our results towards milder cases. Future research should test these associations in larger, more diverse cohorts and assess functional deficits relative to healthy controls.

SIGNIFICANCE/CLINICAL RELEVANCE: Despite widespread assumptions that tendinopathy decreases plantar flexor function, our findings show that functional asymmetries in Achilles tendinopathy are neither large nor consistent and often defy clinical expectations. Our results show that while group-level deficits exist, individual variability is substantial. Many patients perform equally well or better on their most symptomatic limb. These findings call into question the reliability of single-task assessments and supports the need for a battery of tests for evaluating tendon-related dysfunction. Our findings support clinical paradigms that carefully consider the initial functional deficits (or surpluses) of patients at their initial evaluations to design treatment plans aimed at addressing individual impairments along with promoting tendon recovery to restore pain-free function.

REFERENCES: [1] O'Brien+, *Foot Ankle Clin*, 2005; [2] Baxter+, *Med Sci Sports Exerc*, 2021; [3] Scott+, *Brit J Sports Med.*, 2020; [4] Silbernagel+, *Knee Surg Sports Traumatol Arthrosc*, 2006; [5] Ohberg+, *Scand J Med Sci Sports*, 2019; [6] Hasani+, *Sports Med-Open*, 2021; [7] Sara+, *Exerc Sport Mov*, 2023

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IMAGES AND TABLES:

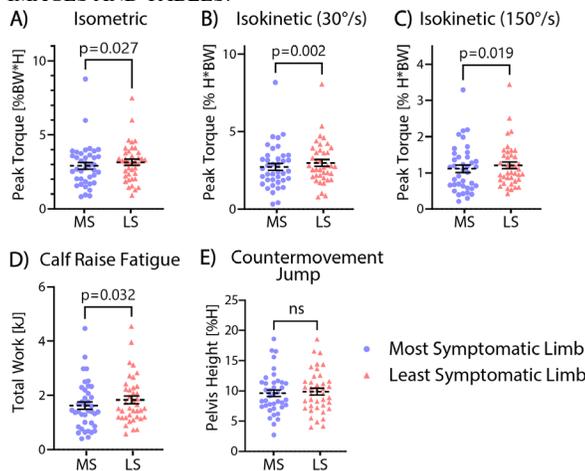


Figure 1. Paired comparison of performance between limbs across functional tests. Bars indicate mean±se

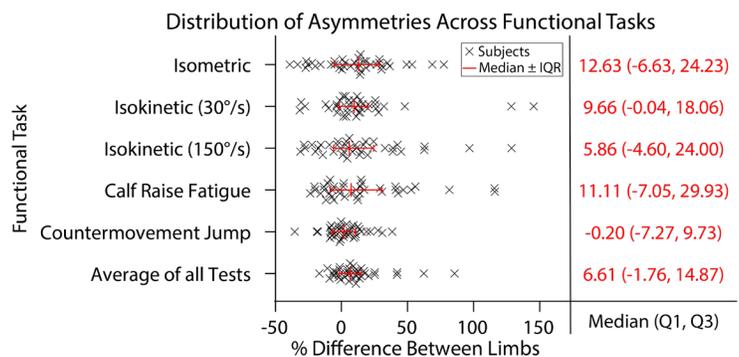


Figure 2. Distributions of asymmetries across functional tests. Percent differences below 0 indicate the most symptomatic limb outperforming the least symptomatic limb.