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Review

New lower-limb gait biomechanical characteristics in individuals with Achilles tendinopathy: A systematic review update

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ABSTRACT

Background: Variations in lower-limb biomechanics have recurrently been associated as aetiological factors for Achilles tendinopathy.
Objective: To update a previous systematic review examining lower-limb gait biomechanics in Achilles tendinopathy.
Design: Systematic Review.
Data sources: MEDLINE, EMBASE, CINAHL PLUS, SPORTDiscus and PUBMED databases searched from inception to May 2016.
Eligibility criteria for selecting studies: Studies investigating adults with Achilles tendinopathy and lower-limb gait biomechanics including kinematics, kinetics, dynamic plantar-pressures, temporospatial parameters and muscle activity.
Results: Fourteen studies were identified, involving 836 participants. Three were prospective studies and 11 were case-control designs. Selection and performance bias were high for all studies except the prospective studies, reporting bias was unclear for all studies.

Significant effect size reductions in gait speed (d = −0.80), stride length (d = −0.84) and step length (d = −0.80) were calculated in runners with Achilles tendinopathy.

Increased effect sizes for ankle eversion (d = 1.08), time to maximum pronation (d = −1.72), calcaneal inversion (d = −1.82) and ankle and hip joint moments were also established.

Significant differences in plantar pressures and timing of ground reaction forces were calculated. Individuals with Achilles tendinopathy demonstrated differences in amplitude and timing of several lower-limb muscles, notably reductions in the onset of activity (d = 2.02) and duration of activation (d = 2.11) in the Gluteus Medius of subjects with Achilles tendinopathy.
Conclusion: Eighteen new biomechanical characteristics in individuals with Achilles tendinopathy have been established. This review highlights a topic rich in quantity, but generally weak in quality, consequently results should be interpreted cautiously. High powered prospective studies are required to determine causality.

Key points

- Reductions in gait speed, step length, stride length and onset and timing of gluteal muscle activity exist in runners with Achilles tendinopathy.
- Greater ankle and hip joint moments exist in individuals with Achilles tendinopathy.
- Further investigation is required to quantify the association precisely, enabling clinical applications of these characteristics.

1. Background

1.1. Achilles tendinopathy

Achilles tendinopathy is a term that describes pain, swelling and dysfunction of the Achilles tendon [1,2]. Previously the terminology frequently used by clinicians and researchers has been complicating and in cases inaccurate. 'Achilles Tendinitis' has previously widely been used to describe Achilles tendon pain despite no evidence of inflammation noted on biopsies [1]. Maffuli et al. have recommended the terms 'Tendinitis' and 'Tendinosis' (degeneration of the tendon) be only used following confirmation of the condition using histopathology,

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surgical exploration or radiographic imaging [1]. 'Achilles tendinopathy' is now the preferred term accepted by the general consensus prior to definitive verification [3].

Achilles tendinopathy can be broadly classified into insertional and mid-portion. Insertional tendinopathy defined as at the calcaneus-tendon junction and mid-portion as 2–6 cm proximal to the Achilles tendon insertion [4].

Achilles tendinopathy is one of the most common lower-limb overuse sports injuries. The majority of studies investigating Achilles tendinopathy epidemiology have been focused on athletic individuals. Kvist et al. reported an incidence of Achilles tendon complaints (97% tendinopathy and 3% rupture) of 14% in 3336 athletes [5]. Annual incidence rates of Achilles tendon complaints have been reported as 7% and 9% respectively in elite runners [6,7]. In a large cohort study of 57,725 Dutch patients registered with a general practitioner, De Jonge et al. reported an annual incidence rate of mid-portion Achilles tendinopathy as 1.85 per 1000 patients registered. Crucially only 35% of the cases in the study was related to sports activity [8].

Despite the significant incidence the exact aetiology remains unknown and is considered multi-factorial. Variations in lower-limb biomechanics including lower-limb kinematics, kinetics and muscle activity have been recurrently associated as aetiological factors for Achilles tendinopathy [9,10]. Anatomical malalignment and poor neuromuscular control are thought to result in uneven loading and stress within the Achilles tendon subsequently resulting in microtrauma [11].

1.2. Biomechanics

Lower-limb biomechanical studies in the literature can be broadly divided into lower-limb kinematics, kinetics, electromyography and temporospatial characteristics.

1.2.1. Kinematics

Kinematics involves the recording of optical motion data to identify and calculate positions, angles, velocities, and accelerations of body segments and joints. This is often done from multiple planes including frontal, sagittal and transverse [12,13].

1.2.2. Kinetics

Gait kinetics is the analysis of the ground reaction forces and plantar pressures produced during movement. Ground reaction forces are measured using fixed force plates, or now more commonly instrumented treadmills (in-built force plates) [14,15].

1.2.3. Electromyography (EMG)

EMG is a technique used to measure electrical skeletal muscle activity, including duration, amplitude and muscle activation timing. Commonly this involves the use of electrodes attached to the overlying skin surface of the tested muscle. In gait studies, EMG can be used to analyse how different muscles are activated during the gait cycle [16].

1.2.4. Temporospatial characteristics

Temporospatial characteristics are the fundamental parameters of an individual's gait recorded during the gait cycle. These parameters include the measurement of time and distance of steps and strides and phases of the gait cycle, from initial contact to toe-off and also the calculation of speed including gait speed and cadence (step frequency). These parameters are often accurately acquired using kinematic or kinetic techniques [17].

1.3. Justification

Identifying the risk factors and evaluating the strength of the evidence will aid in the understanding of the relationship between gait biomechanics and Achilles tendinopathy and is crucial in the development of improved preventative measures and treatment strategies. Progressing on the last review on this topic completed in 2011 [18], we have identified a number of biomechanical factors in studies prior to 2011 not analysed in the last review; furthermore, we have identified 5 new studies since 2011, including studies on walking gait and additional prospective studies. Collation and critical appraisal of this new evidence is now required.

2. Objective

This systematic review update aims to:

1. Identify, evaluate and summarise the new and existing evidence examining lower-limb gait biomechanical factors during walking and running in adults with Achilles tendinopathy and calculate the effect sizes.

3. Methods

This systematic review was designed and conducted according to guidelines outlined by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [19]. This review was registered with PROSPERO (Prospective Register of Systematic Reviews) number CRD42016049677 and the protocol can be accessed here: http://www.crd.york.ac.uk/prospero/display_record.asp?ID = CRD42016049677

3.1. Information sources

MEDLINE (OVID), EMBASE, CINAHL PLUS, SPORTDiscus and PUBMED electronic databases were searched from inception to May 2016 (week 4).

3.2. Search strategy

A targeted and reproducible literature search of the above databases was conducted by two authors (IO and BK). No filters were applied to capture new articles still in press. The search was restricted to human studies and articles published in English. Search outputs were exported to Endnote X7 *(Thomson Reuters, Carlsbad, California, USA)* individually and a master file was created including all search outputs. Duplicates were found and removed using the in-built endnote function "find duplicates". All details of the search including hits of each database, total overall hits and number of duplicates was recorded. Search algorithms were created using pre-defined search terms and Boolean operators. (Appendix A)

3.3. Eligibility criteria

Articles were screened for eligibility using the criteria below:

3.3.1. Inclusion criteria

3.3.1.1. Participants.

- Human adults with confirmed (Clinician/Imaging/Histopathology) Achilles tendinopathy/Tendinitis/Tenosynovitis/Tendinosis/Tenopathy/Paratenonitis/Peritendinitis/Achiilodynia. (Due to previous terminology to describe Achilles tendinopathy)

3.3.1.2. Interventions.

- Studies investigating the association between Achilles tendinopathy and lower-limb biomechanics during walking or running.

3.3.1.3. Comparisons.

- Healthy control adults with no previous history of Achilles tendinopathy and no concurrent musculoskeletal injuries.