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Review

Imaging modalities in the diagnosis and monitoring of Achilles tendon ruptures: A systematic review

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ABSTRACT

Objective: To determine the role of imaging in the diagnosis and monitoring of the Achilles tendon rupture (ATR).
Study design: Systematic review.
Data sources: PubMed and EMBASE in November 2016.
Eligibility criteria: Clinical studies providing information on the methods and role of imaging in the diagnosis and monitoring of the ATR were included.
Results: Fifty-six studies were included, most concerning the use of ultrasound (n = 37) or MRI (n = 18). Seven studies provided data on the diagnostic accuracy of imaging. Most ultrasound studies used a 7.5 MHz probe (19/32 studies) and scanned the patient bilaterally in prone position, with recent studies tending to use higher frequency probes (r = 0.42). Sensitivity [for detecting a rupture] ranged from 79.6 to 100%; the spread in specificity was large but two studies showed perfect (100%) data. Negative and positive likelihood ratios ranged from 0 to 0.23 and 1.0 to 10 respectively.
MRI examination was generally performed with 1.5 Tesla (T) MRI (6/12 studies) with a strong trend for higher T strength in more recent studies (r = 0.71). One study reported a sensitivity of 90.9% and one a specificity of 100%.
Although imaging can visualize structure and healing, these results were generally not related to the clinical picture. Overall, ultrasound was recommended over MRI for diagnosis and monitoring. Results of other imaging modalities remain inconclusive.
Conclusion: The adjunct role of imaging, especially of ultrasound and MRI, in the diagnosis and monitoring of ATRs was established. It is therefore recommended to rely primarily on the clinical examination and evaluation and to use imaging for ruling out other injuries and providing additional clinical information. More high-quality research is warranted into the diagnostic accuracy of imaging as well as less conventional imaging modalities' diagnostic and monitoring capabilities.

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Introduction

The Achilles tendon rupture (ATR) is a common sports injury that shows globally increasing incidence figures [1–9], that are expected to increase further, especially in the elderly, likely as a result of higher participation in recreational physical activity [10,11]. This injury significantly impairs patients with deficits persisting from 1–2 to even 10 years after injury [12,13].

Despite the increasing incidence, long-term impairment and necessary clinical procedures requiring significant time away from work/sport the treatment guidelines for ATRs are inconclusive [14], leading to possible unnecessary increased healthcare costs and an inefficient clinical protocol. Specifically the role of imaging in the diagnosis and monitoring of ATRs is not substantiated [14].

Given that misdiagnosis of ATRs delays treatment leading to chronicity and more (functional) morbidity [15], efficient diagnosis is essential. Currently, clinicians tend to rely on functional tests (e.g. the Thompson test) for diagnosis; imaging (ultrasound and MRI) is said to be reserved for the "difficult patient" [16,17]. Additionally, conservative (non-surgical) treatment is becoming increasingly common and clinicians now place a greater emphasis on early weight-bearing [7,9,18]. Imaging could have a larger role in predicting and preventing the most significant complications, re-ruptures and wound infections, during the recovery phase [19]. Despite this, the role of imaging in monitoring the increasingly emphasized rehabilitation phase is unknown [20,21].

Hence, the aim of this systematic review study was to determine the role of imaging in both the diagnosis and monitoring of the ATR. This review determined how imaging is used in ATR patients, its (additional) value in the diagnosis and/or monitoring, and strived to gain insight into the relationship between imaging and the clinical picture. Additionally, diagnostic accuracy measures were determined for the available imaging modalities to objectify the diagnostic role of imaging.

Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses protocols (PRISMA-P) [22].

Search strategy

A systematic electronic search of PubMed and EMBASE was conducted on all studies, published between 1995 in November 2016, and providing information on the role of imaging in diagnosing and monitoring ATRs. Implementation and validation of the search and search methods was attained from a Medical Librarian at the University Medical Center Groningen (see the Appendix for the complete search string). All records were imported into Refworks (ProQuest, Bethesda, MD). Backward citation tracking was performed on all included articles.

Inclusion criteria and procedure

Clinical studies assessing imaging techniques in either the diagnosis and/or monitoring (of treatment) of complete ATRs were considered eligible. Studies were only included if they provided information on the methodology of imaging examination and/or provided imaging-specific outcomes. Only studies written in English, Dutch or German languages were included. This review excluded studies focusing on the use of imaging during or as a part of treatment. Case-studies, abstracts, reviews, editorials and animal-studies were excluded.

Three reviewers were involved in the study selection process. Two reviewers (OCD and JZ) independently selected the studies in three successive rounds. First the specified criteria were applied to the titles, then the abstracts and finally the full texts. In case of uncertainty a study proceeded to the next round. Disagreement was resolved by consensus, and if agreement was not achieved, a third reviewer (IHFR) was consulted.

Data extraction and analysis

The following data were extracted from the full texts of the included studies:

Study information: year and first author(s), study design.

Methodology: patient characteristics and number, follow-up, injury and treatment applied, imaging methods and settings.

Outcomes: recommendation for imaging in diagnosis and/or monitoring, (changes in) tendon structure on imaging after injury and differences depending on treatment, association of imaging with other outcomes.

Studies comparing ATR diagnostic data to a reference standard (intraoperative confirmation) were included in diagnostic accuracy calculations. Data required to calculate sensitivity/specificity and positive/negative likelihood ratios (LR+/LR−) were extracted. One author (OCD) extracted data from the included studies. Extracted data was verified by a second author (JZ).

Methodological quality assessment

All studies were assessed for methodological quality using the Downs and Black (D&B) checklist for randomized and non-randomized studies [23]. The original checklist contains 27 questions amounting to a maximum of 32 points. We modified

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