THE VALUE OF SONOELASTOGRAPHY AS AN ADJUVANT TO ULTRASONOGRAPHY IN DIAGNOSIS OF CASES WITH SYMPTOMATIC ACHILLES TENDON : CORRELATION TO MRI

THESIS

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By

Maha Ahmed Abdelkarim Othman
(M.B.B.CH)
Cairo University

Supervisors

Prof. Dr. Nagui Mohammed Abdelwahab
Prof. of Radiodiagnosis
Faculty of Medicine
Cairo University

Dr. Hatem Mohamed Elazizy
Assistant Prof. of Radiodiagnosis
Faculty of Medicine
Cairo University

Cairo University
2014

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Abstract

Introduction: Sonoelastography is a new ultrasound based technique. It is used to assess tissue elasticity during ultrasound examination .The Achilles tendon is the largest and strongest tendon of the human body, yet it is commonly affected by injuries and degeneration.

Aim of work: We investigated the feasibility of sonoelastography in the diagnosis of Achilles tendon disorders, and correlated our results with MRI.

Patients and methods: Twenty patients with pain related to the Achilles tendon were included in the study. They were examined by ultrasound, sonoelastography and MRI. The elastograms were divided into 3 grades: *Grade 1* : area of marked softening (blue) about (0 – 25%) of the tendon, *Grade 2* : blue area about (25 - 50%) ,*Grade 3*: blue area more than 50% of the tendon. MRI grading was done as follows: Grade 1 : normal tendon , Grade 2 : thickened tendon, Grade 3: intratendinous abnormal signal. Agreement between both was calculated.

Results: All tendons showed variable degrees of softening. Elastography and MRI showed moderate agreement ($\kappa = 0.44$; $P < 0.001$)

Conclusion: Sonoelastography is a feasible method in assessment of Achilles tendon abnormalities.

Key words: Elastography, sonoelastography , Achilles tendon , Musculoskeletal ultrasound , MRI.

List of Abreviations

AP	anteroposterior
AOFAS	American orthopedic foot and ankle society
AS	ankylosing spondylitis
AT	Achilles tendon
B-mode	brightness mode
CT	computed tomography
EFOV	extended field of view
EI	elasticity imaging
EUS	elastography ultrasound
FH	familial hypercholesterolemia
FHL	flexor hallucis longus
GE	gradient echo
Hz	Hertz
HU	Hounsfield units
KHz	kilo Hertz
kV	kilo Volt
LDL	low-density lipoprotein
LDLR	low-density lipoprotein receptor
mA	milli Ampere
MHz	mega Hertz
MRE	Magnetic Resonance Elastography

MRI	magnetic resonance imaging
N.	number
N m^{-2}	Newton per square meter
Pa	Pascals
RTE	Real-time tissue elastography
RTSE	Real-time sonoelastography
ROI	region of interest
SE	spin echo
SE	Sonoelastography
SD	standard deviation
SPSS	Statistical Package for the Social Science
STIR	short tau inversion recovery
T	Tesla
T1WI	T1 weighted image
T2WI	T2 weighted image
TE	time of echo
TR	time of repetition
TTI	Tissue type imaging
US	ultrasound

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Introduction

The Achilles tendon is the largest tendon in the body and its function is to plantar flex the ankle ***(Nandkumar et al, 2000)***. It is formed by confluence of the individual tendons of the gastrocnemius and soleus muscles***(Bianchi et al, 2005***)

Achilles tendon disorders frequently occur in athletes, as well in the general population.***(Klauser et al,2013)*** Ultrasonography is an efficient and accurate imaging method for evaluation of Achilles tendon abnormalities **(*Tan S.et al.2012)*** .However, using conventional ultrasound, it is sometimes difficult or even impossible to distinguish pathologic tissue because it often presents with the same echogenicity as the surrounding healthy tissue ***(Frey H.et al.2003)***

Real-time sonoelastography is a new ultrasound-based technique able to assess tissue elasticity that has already shown feasibility in tumor diagnosis.***(De Zordo et al.,2009)***

The principle of elastography is that tissue compression produces a strain (displacement) within the tissue, and this strain is less in hard tissue than in soft tissue, thus allowing an objective determination of tissue stiffness ***(Tan et al,2012***)

While the primary clinical application of elastography remains for tumor detection, its potential application to musculoskeletal tissues has increasingly driven research activity around the development of new approaches and the translation of existing approaches to clinical devices. ***(Li & Snedeker 2011).***

The Achilles tendon has provided most of the clinical data available so far in musculoskeletal applications; it was the first area to be investigated using free-hand strain EUS ***(Drakonaki et al,2012)***

Normal Achilles tendons with a normal B-mode appearance (i.e., uniform fibrillar appearance, with normal bulk and echotexture) show predominant blue color on the SE, indicating the hard nature/consistency of normal young tendons. Small variable patches of green color may also be seen in normal tendons***.(Lalitha et al.,2011)***

Patients with frank clinical and B-mode ultrasound features of Achilles tendinitis (i.e., bulky tendon, with hypoechoic texture and loss of the fibrillary pattern on B-mode ultrasound) reveal predominantly red color on the SE; this indicates a soft tendon, with loss of the normal hard/firm consistency**. *(Lalitha et al 2011).***

Owing to its multiplanar imaging capabilities and excellent soft tissue contrast characteristics, MRI is a useful modality for imaging the Achilles tendon. ***(Wijesekera et al,2011)*.**

MRI allows a global evaluation of the bones, tendons, ligaments, and other structures with a single examination that exceeds the capabilities of all other available techniques **(*Lucas. et al.,1997).***

AIM OF WORK

The aim of this study is to assess the feasibility of using sonoelastography in cases with Achilles tendon disorders, describing the elastographic patterns and correlating the results to MRI as a gold standard.

Anatomy of the Achilles tendon

The Achilles tendon is the largest tendon in the body and its function is to plantar flex the ankle ***(Nandkumar et al, 2000)***. It is formed by confluence of the individual tendons of the gastrocnemius and soleus muscles. During its course, the tendon fibers rotate laterally for 90 degrees so that those of the soleus component insert into the postero-medial aspect and that from the gastrocnemius inserts into the posterolateral aspect of the calcaneus. ***(Bianchi et al, 2005)***.

The gastrocnemius accounts for two thirds of the fibers of Achilles tendon and soleus contributes one third but variation in this pattern occurs in adults, the tendon is about 10 to 15 cm in length and has a thickness of 4-7 mm ***(Bianchi et al, 2005)***.

The Achilles tendon is rather cord-like proximally but fans out just above its insertion so it becomes twice wide as thick. A small bursa **(retrocalceneal bursa)** is interposed between the anterior surface of the tendon and the superior margin of the calcaneus. Another bursa **(retroachilles bursa)** is located between the skin and the posterior surface of the tendon near its calcaneal insertion ***(Mink et al, 1992).***

It has no sheath, however there is a vascular peritenon that has extend into tendon substance. Two to six cm above the ankle there is some reduction in the vascular supply (***Davies, 2005).***