Quantitative measurement of Achilles tendon strain using tissue elastography

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Yohei Yamamoto

My disclosure is in the Final AOFAS Program Book. I have no potential conflicts with this presentation.
Degeneration of the Achilles tendon is assessed using MRI and conventional ultrasonography. However, these are qualitative (or semi-quantitative) measures, and there is no quantitative method. Tissue elastography is a new ultrasound technique which measures tissue elasticity. The strain of the Achilles tendon with tendinopathy is lower (i.e. softer) than the normal tendon.

Recently quantitative tissue elastography has developed, and used to differentiate between benignancy and malignancy of breast tumors.
Purposes

- To measure intraobserver repeatability of quantitative elastography of the Achilles tendon in healthy subjects
- To compare the elastography values among different age groups
- To assess correlation between quantitative elastography and conventional qualitative ultrasonographic measurements
Methods

- One-hundred tendons of 50 healthy volunteers
- 25 men and 25 women; 5 men and 5 women in each decade of age from their 20s to 60s

Measurement

- Longitudinal image of the middle third of the tendon
- Relaxed prone position
- Insertion at the calcaneus
- Musculotendinous junction

Ultrasonography

- Hi Vision Preirus (Hitachi Aloka Medical, Japan)
- Linear probe 6~14MHz
- Acoustic coupler of known elasticity (22.6±2.2kPa) attached to the probe

Examiner: one experienced orthopaedic surgeon
1. Repetitive pressure applied to the tendon using the probe
2. Color mapping of the tissue strain
3. Region of interest  **A**: Achilles tendon  **B**: Coupler
4. Strain ratio (SR) = \[
\frac{\text{The strain of coupler (B)}}{\text{The strain of Achilles tendon (A)}}
\]
Evaluation

- Intraobserver repeatability of the SR measurement
  - Measurement of the SR four times consecutively for each tendon
  - Intraclass Correlation Coefficient (ICC) (1, 1) and standard error

- Comparison of the SR values among different age groups
  - 20s – 60s
  - Kruskal-Wallis test (p < 0.05)

- Correlation between the SR and conventional qualitative measurements
  - Mean SR value for each tendon
  - B-mode image (Grade 1: normal, 2: enlarged, 3: hypoechoic)
  - Qualitative elastography (Grade 1: blue-hard, 2: yellow-medium, 3: red-soft)
  - Wilcoxon signed-rank test (p < 0.05)
Results (1)

- **Average SR**: 2.88 ± 0.92
- **ICC (1, 1)**: 0.76 (Substantial)
- **Standard error**: 0.10

**SR values among different age groups**

- **20s**: 2.81 ± 0.61
- **30s**: 3.80 ± 0.57
- **40s**: 2.67 ± 1.08
- **50s**: 2.61 ± 0.82
- **60s**: 2.52 ± 0.88

* p < 0.001 in Kruskal-Wallis test

* p < 0.001 in post-hoc test (Steel-Dwass)
Results (2)

- SR vs. B-mode evaluation
- SR vs. qualitative elastography

For B-mode evaluation:
- Grade 1: 2.93 ± 0.91
- Grade 2: 1.51 ± 0.12
- Grade 3: Average not shown, n = 0

For qualitative elastography:
- Grade 1: 3.36 ± 0.81
- Grade 2: 2.17 ± 0.57
- Grade 3: Average not shown, n = 0

Significance levels:
- *p = 0.004
- *p < 0.001
Conclusion

- SR measurement of the Achilles tendon was a reproducible method.

- SR values were similar among different age groups except for the 30s.

- SR value correlated with the conventional ultrasonographic evaluation of Achilles tendon degeneration.

- *Quantitative* elastography may be a useful method to quantify degeneration of the Achilles tendon.

Reference