Oct 16, 2020

Development of an anatomic landmark-based measurement of the Achilles tendon

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1 *Works for me* dx.doi.org/10.17504/protocols.io.beaejabe

Daniel Urness

ABSTRACT

Introduction

Achilles tendon ruptures (ATRs) occurred with an incidence of 2.5 per 100,000 person-years in 2016. This rate has been increasing over the last decade and it has been postulated that this is due to the increasing activity level of older people. With a high and increasing incidence of such a significant injury, further investigation must be done to optimize the treatment of ATRs. The degree of tendon lengthening has been correlated with clinical outcomes, with greater elongation being associated with worse outcomes. MRI and ultrasound techniques have been validated in measurement of Achilles tendon. We sought to develop a reliable, reproducible, and accurate measurement technique utilizing the manual palpation of anatomic landmarks that will be cost effective as well as convenient to perform, particularly intraoperatively.

Methods

Both lower legs of 10 healthy subjects without history of Achilles tendon injury were examined using ultrasound and anatomic landmark-based measurement techniques. Subjects sat upright on the exam table and legs were held in flexion at the knee with slight external rotation with the ankle held at 90^{o}, allowing the lower leg to rest flat on the exam table. The length from the medial head of the gastrocnemius to the bottom of the non-compressed heal pad was measured by three raters using the ultrasound and anatomic landmark-based techniques for inter-rater reliability. The measurements were repeated one week later for intra-rater reliability. Ultrasound measurements had excellent inter-rater (0.93) and intra-rater (0.82) correlation coefficients, while good inter-rater (0.76) and intra-rater (0.86) correlation coefficients were observed among anatomic landmark-based measurements. Achilles tendon length measured with ultrasound and anatomic landmark-based techniques were compared using a paired t-test.

Results

The anatomic landmark-based technique produces longer measurements of the Achilles tendon (23.2 cm (sd 2.6 cm)) compared to measurements made using ultrasound (22.4 cm (sd 2.6)) ($p<0.001$). On average, the anatomic landmark-based technique measures 0.8 cm (95% Confidence Interval: 0.4, 1.2) longer than the ultrasound technique. The intraclass correlation coefficient between the anatomic landmark-based and ultrasound measurements is 0.90.

Conclusions

While the anatomic landmark-based technique produces a longer measurement of the Achilles tendon, it may still be a reproducible measurement tool. If the change in tendon length is of interest, this technique may be a valid and simple way to monitor that variable. Comparison with MRI may be warranted to better determine the accuracy of the anatomic landmark-based Achilles tendon measure. These results compared with MRI may set the stage for further evaluation of this measurement technique in the operating room in subjects undergoing ATR repair.

DOI

dx.doi.org/10.17504/protocols.io.beaejabe

PROTOCOL CITATION

Daniel Urness 2020. Development of an anatomic landmark-based measurement of the Achilles tendon. **protocols.io** https://dx.doi.org/10.17504/protocols.io.beaejabe

Citation: Daniel Urness (10/16/2020). Development of an anatomic landmark-based measurement of the Achilles tendon. https://dx.doi.org/10.17504/protocols.io.beaejabe

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KEYWORDS

Achilles tendon, Achilles tendon rupture, rupture, ultrasound, US, MRI

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CREATED

Mar 26, 2020

LAST MODIFIED

Oct 16, 2020

PROTOCOL INTEGER ID

34854

MATERIALS TEXT

Industrial steel framing square
Tape measure
Marking pen
Paper clip
alcohol pads
Ultrasound machine with gel
MRI machine

SAFETY WARNINGS

None

ABSTRACT

Introduction

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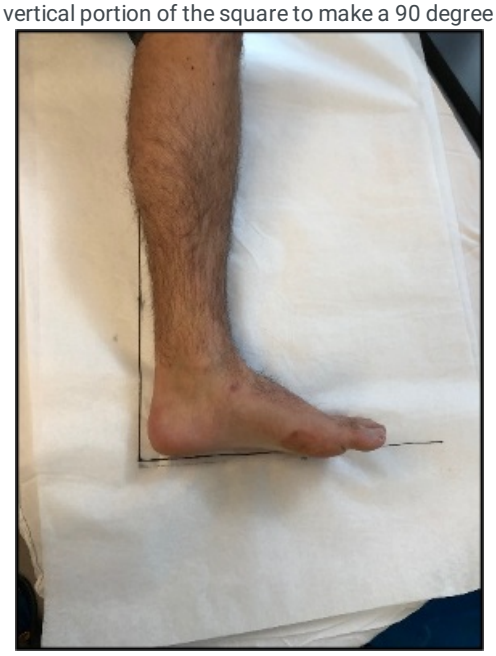
technique. The intraclass correlation coefficient between the anatomic landmark-based and ultrasound measurements is 0.90.

Conclusions
While the anatomic landmark-based technique produces a longer measurement of the Achilles tendon, it may still be a reproducible measurement tool. If the change in tendon length is of interest, this technique may be a valid and simple way to monitor that variable. Comparison with MRI may be warranted to better determine the accuracy of the anatomic landmark-based Achilles tendon measure. These results compared with MRI may set the stage for further evaluation of this measurement technique in the operating room in subjects undergoing ATR repair.

Positioning

1 1. Position subject sitting upright with hip flexed, abducted, and externally rotated so the lateral aspect of the lower leg lays flat over the outline of the framing square
2. Align the plantar aspect of the foot with the base of the framing square and the posterior aspect of the calf with the vertical portion of the square to make a 90 degree angle at the ankle joint.



Anatomic landmark-based measurement

2 1.With subject positioned as above, palpate the step off where the medial head of the gastrocnemius becomes the Achilles tendon.

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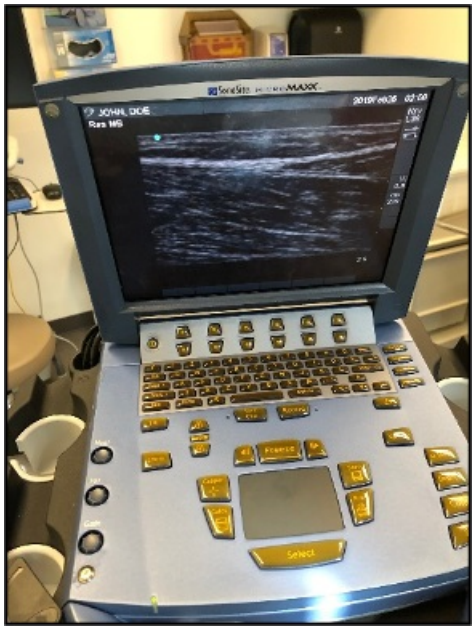
2. Mark above location with marking pen.
3. Using a tape measure, measure from that mark to the base of the non-compressed heel pad and record
4. Remove marking pen with alcohol pad and repeat for 3 measurements on both lower legs for a total of 6 measurements.
5. Rotate subjects to next rater until each rater has recorded measurements for each subject.

Ultrasound measurement

3 1. With the subject positioned identically to the anatomic landmark-based technique, use the ultrasound to identify the confluence of the medial head of the gastrocnemius and the Achilles tendon.



2. Mark this landmark. (The authors used a paper clip to mark this location on the ultrasound and then marked the area with a marking pen)
3. Using a tape measure, measure from that mark to the base of the non-compressed heel pad and record.
4. Remove marking pen with alcohol pad and repeat for 3 measurements on both lower legs for a total of 6 measurements.
5. Rotate subjects to next rater until each rater has recorded measurements for each subject.

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MRI Positioning

4 1. Position patient supine with bilateral ankles at 90 degrees in MRI scanner.
2.Image must capture medial head of the gastrocnemius and distalmost portion of the non-compressed heelpad.
3. Obtain axial, coronal, and sagittal T1 series for bilateral legs.

MRI Measurement

5 1. Identify confluence of the medial head of the gastrocnemius with the Achilles tendon using an axial cut and identify corresponding landmark on a sagittal or coronal image.
2. Using either coronal or sagittal cut, identify distalmost portion of the non-compressed heelpad.
3. Measure the distance between the two above landmarks using imaging software.
4. Each measurement is made once on each leg by two separate raters.

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