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Clinical Research

Assessing Lateral Ankle Sprains With a New Arthrometer

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Abstract: Background. *Lateral ankle sprains are a common musculoskeletal injury across a variety of activities. Researchers have sought to identify a method to objectively assess joint laxity with a device that is simple to use and affordable.* Aim. *The purpose of this study was to assess the use of an ankle arthrometer on individuals with ankle sprains.* Methods. *The participant was evaluated by the physician and the degree of ankle sprain was identified. In the prone position, the arthrometer was used to perform an anterior drawer test (uninjured before injured, 3 measures each). Both clinicians were blinded to the data of the other.* Results. *There were 30 participants, 10 in each group (uninjured, grade 1 sprain, grade 2 sprain). Mann-Whitney U testing found significant differences between the control and grade I ankle sprain groups ($P < .001$), the control and grade II ankle sprain groups ($P < .001$), and the grade I and grade II ankle sprain groups ($P = .004$). There was ±0.31-mm difference in anterior translation between healthy ankles, whereas there was 1.11- and 2.16-mm difference between ankles in grade 1 and grade 2 sprains, respectively.* Clinical Application. *Despite the manual anterior drawer test being convenient, the subjectivity makes it unreliable. This study is consistent with prior literature about the difference in translation (millimeters) between the uninjured and injured ankles corresponding to the magnitude of ankle laxity. This study also contributes to the evolving evidence to support the relationship of a ratio of measures (injured/uninjured) as an objective measure of laxity. These comparisons to the individual's healthy ankle mitigate the variability of the normative values. The use of an arthrometer to assess ankle joint laxity enhances the objectivity of patient assessment throughout the recovery process.*

Levels of Evidence: [AQ: 1]

Keywords: ankle sprain; arthrometer; ankle instability

Lateral ankle sprains are a common musculoskeletal injury across a variety of activities.[1] The mechanism for this injury is typically excessive ankle inversion. Despite the fact ankle sprains are seen as benign injuries that resolve with minimal treatment, many become chronic problems.[1,2] Residual ankle instability can persist if proper treatment is not rendered.[3] Proper treatment begins with an accurate diagnosis.

The anterior talofibular ligament (ATFL) is the primary ligament involved in lateral ankle sprains. The calcaneofibular ligament (CFL) can also be involved. The common mechanism is inversion with internal rotation for ATFL and inversion (without rotation) for CFL.[4] The ATFL is the chief restraint to anterior displacement of the talus.[5] However, both ligaments are incriminated with an anterior drawer test (ADT).[6-10] The ADT can be performed in the supine (Figure 1) or prone position (Figure 2). In either position, the distal tibia is stabilized, while the talus is translated anteriorly on the tibia. The magnitude of the

"The use of an arthrometer to assess ankle joint laxity enhances the objectivity of patient assessment throughout the recovery process."

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Figure 1.

Supine ankle anterior drawer test.

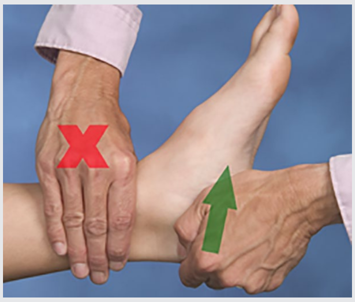


Figure 2.

Prone ankle anterior drawer test.

translation relative to the uninvolved ankle is an indication of the degree of injury.

Although the ADT is widely accepted, the reliability has been questioned because of the subjective nature involved in the interpretation of the displacement.[11-13] Inconsistencies among studies suggest the ADT may not be a sensitive tool to evaluate mechanical changes resulting from an ankle sprain.[1,12-14] The use of ultrasound with anterior drawer stress has demonstrated good to excellent inter-rater reliability.[3] However, availability, cost, and the need for a skilled clinician to operate the device can be a challenge. Teramoto et al[15] developed capacitance-type sensors that were successful in testing cadavers, but the device is not commercially available. The Telos stress device can be used with either ultrasound or radiographs to apply a consistent stress[15] but the cost can be a barrier. In addition, the Telos applies a preselected amount of force (150 N). Because the viscoelastic properties of the ankle may change with a sprain, the set force may not be appropriate.[1] Studies have suggested the rate of force application may be important as the magnitude of laxity increases.[16]

Researchers have sought to identify a method to objectively assess joint laxity with a device that is simple to use and affordable. The purpose of this study was to assess the use of an ankle arthrometer called the Mobil-Aider (Therapeutic Articulations, Spring City, Pennsylvania) on individuals with ankle sprains. The goal was to determine the ability of the arthrometer to objectively identify the anterior translation of the ankle and the relationship to the clinical diagnosis.

Methods

This interventional study was approved by the Thomas Jefferson University Institutional Review Board for the Protection of Human Subjects (# 21D.468). Participants were patients who had scheduled appointments with a podiatric physician at the Rothman Institute for an ankle sprain. The physician examined the patient via the standardized process. If the physician diagnosed the patient with an ankle sprain, a referral was made to the researcher.

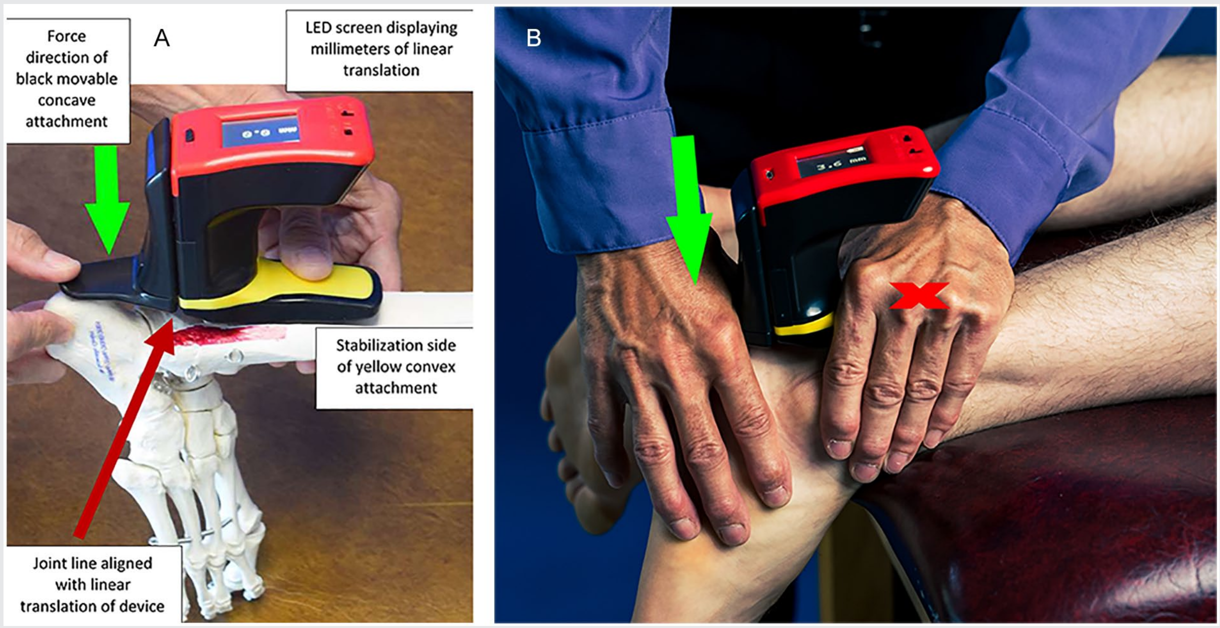
The researcher explained the study to the patient and obtained consent. The inclusion criterion was a current ankle sprain with no other foot or ankle pathology, including but not limited to fracture(s). Individuals with known connective tissue disorders were also excluded. In addition, the contralateral ankle must be free of pathology. If the inclusion criteria were met, the technique using the Mobil-Aider arthrometer was demonstrated to the participant. The consent form was reviewed and signed.

Extremity injured, age, gender, and date of injury were recorded. The participant was asked to assume a prone position on the treatment plinth with the foot and ankle over the edge of the table. The uninjured ankle was tested first. The ankle was positioned in 10° to 15° of plantarflexion. This is the recommended position for ATFL testing because this is where the tibiotalar joint is least stable.[1,3,10,17] The talocrural joint line was identified. A few grade II oscillations were performed to confirm the joint line. The device used in this study was the Mobil-Aider arthrometer (Figure 3A). This arthrometer has a stable side (red side with light-emitting diode [LED] screen) and a side that moves linearly (black side without screen) via an internal rollerball mechanism. Each side of the main body of the device accommodates contoured attachments for a variety of joints. In this case, the yellow convex attachment contours to the posterior distal tibia (gastroc/soleus/Achilles region), while the black concave attachment conforms to the talus/calcaneal region. Both pieces were locked into position on their respective sides of the device via a dovetail fit and plugger mechanism. The axis of the Mobil-Aider was aligned with the talocrural joint line. The proximal side (yellow) of the Mobil-Aider was stabilized against the posterior tibia. The distal side (black) of the Mobil-Aider was held in contact with the talus/calcaneus (Figure 3A and B). Again, a few small oscillations were performed to confirm alignment of the device with the talocrural joint line. Three maximal anterior translations were performed. The LED reading was noted for each translation with the largest one being recorded on the data form. The identical process was performed on the injured ankle. The total magnitude of linear translation the Mobil-Aider can perform is 15 mm. After testing was complete, the physician shared the degree of the ankle sprain via the West Point grading system[18] with the researcher. Thus, both were blinded to the data of the other.

Data were analyzed using SPSS v. 27. Descriptive statistics were calculated for ankle diagnosis; sex, age, and days since diagnosis were calculated. Nonparametric statistics were performed due to the convenience sample. A Kruskal-Wallis

Figure 3.

(A) Anterior drawer test with the Mobil-Aider arthrometer labels (skeletal). (B) Anterior drawer test with the Mobil-Aider arthrometer (clinical).



Abbreviation: LED, light-emitting diode.

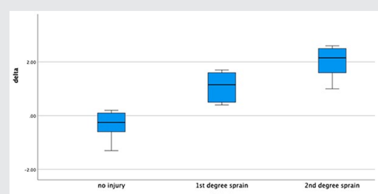
Table 1.

Means and Standard Deviations of the Difference in Translation for the Injured Versus Uninjured Ankle for Each Group.

Group	Mean	Standard deviation
Control—No injury	|±0.31|	0.47
Grade I ankle sprain	1.11	0.52
Grade II ankle sprain	2.16	0.85

Figure 4.

Box plot of differences for each group.



analysis of variance (ANOVA) on the change score between involved and uninvolved side was performed to detect potential between-group differences. Post hoc Mann-Whitney *U* testing was performed to determine where the differences were.

Results

There were 10 participants each in the no injury, grade 1, and grade 2 ankle sprain groups. Twenty-one participants were female and 10 were male. Median age was 35.5 years (ranging from 18 to 67 years). Mean time from injury was 13.9 days.

The Kruskal-Wallis ANOVA detected significant between-group differences ($P < .001$). Mann-Whitney *U* testing found significant differences between the control and grade I ankle sprain groups ($P < .001$), the control and grade II ankle sprain groups ($P < .001$), and the grade I and grade II ankle sprain groups ($P = .004$). Because there was no injury in the control group, the absolute value of the between-ankle difference was used (Table 1). The control group only differed by 0.31 ± 0.47 mm between ankles. The grade 1 sprains demonstrated a mean difference of 1.11 ± 0.52 mm and the grade 2 sprains had almost double the difference in linear translation with 2.16 ± 0.85 mm. A box plot of the differences in measures of anterior translation of the injured verses uninjured ankle for each group is further displayed in Figure 4.

Discussion

Quantifying the magnitude of ankle laxity can be very helpful in determining an appropriate intervention. A study by Teramoto et al[15] compared a capacitance-type strain sensor with a Telos stress device (150 N) and radiographs on cadavers. When comparing uninjured individuals (ie, normal), the magnitude of translation with an ADT was 2.9 ± 0.9 mm (strain sensor), 3.7 ± 1.0 mm (Telos), and 2.7 ± 0.9 mm (radiographs). The capacitance sensors were highly correlated with radiographs and were deemed safe, simple, and accurate. However, capacitance sensors are not readily available to clinicians. Likewise, Dowling, Giakoumis, and Ryan (2014) reported normal range of an ADT to be from 3 to 10 mm with a mean of 2.00 mm ± 1.71 mm using stress radiographs.[19] These values are consistent with those of this study and the work of Kerkhoffs et al,[13] who found sectioning the ATF ligament in a cadaver increased anterior laxity by 2 mm.

Lee et al[3] compared a manual ADT, stress radiographs, and stress ultrasound across normal ankles as well as grade 1, 2, and 3 ankle sprains. The researchers compared the translation related to injury as a ratio to the normal data. They reported the ATFL ratio as ATFL stress/ATFL resting. For grade 1 sprains, the ratio was 1.1 ± 0.1; for grade 2, the ratio was 1.3 ± 0.2; and grade 3 was 1.4 ± 0.2. If the current data are converted into a ratio format, it is slightly higher but very similar. This study revealed a grade 1 ratio of 1.27 ± 0.1 and a grade 2 ratio of 1.67 ± 0.3. Lee et al[3] also concluded stress ultrasound was comparable to stress radiographs. However, classification via manual techniques was only moderately correlated (0.58) with stress ultrasound. Although stress ultrasound is deemed simple and easy to perform, it may not be readily available to all practitioners.

Another study[16] using the Instrumented Ankle Arthrometer (Blue Bay Research Inc, Milton, Florida) reported 10.62 ± 2.62 mm and 11.86 ± 2.68 mm of anterior translation for uninjured and mechanical instability, respectively. Despite having hook-and-loop fastener straps wrapped around the table and the leg at 2 and 12 cm above the lateral malleolus, the application of a 125-N force to a load handle permits significant anterior movement of the tibia before the slack is taken out of the ATFL. This is apparent when watching the video on the use of the Instrumented Ankle Arthrometer (https://bluebayres.com/wp-content/uploads/2021/12/IMG_0360.mp4). Although the assessment of anterior translation may have been overestimated, the difference of 1.24 mm was consistent with the laxity identified with the Mobil-Aider device and similar to the ratio identified by Lee et al[3] for a sprained ankle (1.11). The Instrumented Ankle Arthrometer has been used in numerous research studies. Yet, it is not portable, and it is expensive and cumbersome to set up.

Likewise, the Telos device (TELOS Medical, Millersville, Maryland) has been used in several studies and has been reported to be cumbersome and difficult to use.[3,20-23] Although magnetic resonance imaging (MRI) can be valuable for soft tissue imaging, it is not usually recommended for diagnosis of ankle instability because it is not dynamic. ATFL images depend on the precise cut, it is expensive, and can be very time consuming.[3]

In summary, assessing ankle joint laxity can be challenging. Trying to assign 1 of the 3 subjective grades can be imprecise. An objective measure using an arthrometer can provide a more reliable grade of ankle laxity as well as track the progression of ligament healing over time.[16] It can help to differentiate between mechanical instability and functional instability. Finally, it can assist in determining whether surgical intervention may be warranted.

Clinical Application

Despite the manual ADT being convenient for clinical use, it is unreliable because of the subjective nature.[1] Having the ability to quantify the joint laxity with a tool that is simple to use and readily available can address the subjectivity and potentially enhance the confidence of the clinical assessment when millimeters of motion are the difference between grades of laxity. Given the normative values for anterior displacement have been reported to span from 3 to 18 mm, it is important to have a valid device to quantify this laxity and compare it with the uninjured extremity.[24,25] This study is consistent with prior literature regarding the difference in translation (millimeters) between the uninjured and injured ankles corresponding to the magnitude of ankle laxity. The study also contributes to the evolving evidence to support the relationship of a ratio of measures (injured/uninjured) as an objective measure of laxity. These comparisons to the individual's healthy ankle mitigate the variability of the normative values. The use of an arthrometer to assess ankle joint laxity enhances the objectivity of patient assessment throughout the recovery process.

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Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Dr Dawn T. Gulick declares she holds the patent for the Mobil-Aider device.

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Ethical Approval

This interventional study was approved by the Thomas Jefferson University Institutional Review Board for the Protection of Human Subjects (# 21D.468).

Informed Consent

All participants were appropriately informed of the study parameters and provided informed consent prior to data collection.

Trial Registration

Not applicable.

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