

Reliability of the Anterior Drawer and Talar Tilt Tests Using the LigMaster Joint Arthrometer

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Context: Joint arthrometers have been developed to help determine the severity of ligament sprains. **Objective:** To establish intratester and intertester reliability of the talar inversion and anterior drawer tests using the LigMaster. **Design:** Intratester reliability was investigated using a repeated-measures design. Intertester reliability was investigated using 2 different clinicians testing subjects on the same day. **Setting:** Athletic training research laboratory. **Participants:** Thirty participants volunteered for this study. **Main Outcome Measurements:** Anterior displacement and talar inversion were measured using the LigMaster. **Results:** Intratester reliability was .74 for the talar inversion test and .65 for the anterior drawer test. Interrater reliabilities for the talar inversion and anterior drawer tests were .76 and .81, respectively. **Conclusions:** The LigMaster joint arthrometer is a reliable tool for measuring talar inversion and anterior displacement at the ankle. **Keywords:** ankle, laxity, stress test, inversion

Foot and ankle injuries are prevalent in athletes, accounting for nearly 25% of their injuries.¹ The most common injury is a lateral ankle sprain causing damage to the anterior talofibular ligament, calcaneofibular ligament, and/or posterior talofibular ligament.² Assessment of ankle sprains occurs in a variety of ways, from manual tests to radiographic imaging. Each method has advantages and disadvantages, and clinicians are continually trying to identify diagnostic criteria that are both reliable and valid.

Clinicians primarily rely on manual stress tests to determine the severity of lateral ankle sprains.³ Specifically, the anterior drawer and talar inversion tests are used to identify injuries to the ligaments after an inversion ankle sprain. The anterior drawer test assesses the integrity of the anterior talofibular ligament.³ This ligament is responsible for preventing the anterior displacement of the talus, as well as maintaining stability during internal rotation of the talus on the tibia.⁴ Clinical techniques for performing the manual anterior drawer test have been described by numerous authors,^{3,5,6} but it is generally performed by stabilizing the distal tibia and fibula while pulling the calcaneus and talus in an anterior direction. Increased anterior translation of the talus occurs when anterior talofibular ligament damage is present. The talar tilt, or talar inversion, test is used to evaluate the calcaneofibular ligament.³ The role of the calcaneofibular ligament is to stabi-

lize the talus and the calcaneus, thus preventing excessive inversion of the ankle.⁴ The talar tilt test is conducted by stabilizing the distal tibia and fibula while inverting the calcaneus and subsequently the talus.³ The amount of inversion is the angle between the tibial plafond and the dome of the talus.⁷ When the calcaneofibular ligament is injured the talus will invert excessively within the ankle mortise.⁴

The advantage of manual tests is that no special equipment is necessary; however, several specific disadvantages have also been identified. First, interpretation of the pathologic amount of talar tilt or anterior displacement is subjective.^{8,9} Second, it is difficult for clinicians to standardize the amount of stress applied to the joint.¹⁰ These issues have caused the reliability of the manual stress tests to be questioned.⁸ To help improve the accuracy of assessing ankle sprains, a variety of ankle-joint arthrometers have been developed.

The Telos apparatus is one of the more commonly used joint arthrometers. This U-shaped instrument can create inversion, eversion, and anterior stress to the ankle.¹¹ The Telos apparatus includes a pressure actuator that gradually provides a standardized amount of force to the joint. Because the device does not include a mechanism for evaluating the amount of angular tilt or anterior joint displacement, however, it is primarily used as a stabilizing device during stress radiographs.¹²⁻¹⁴

Stress radiographs are commonly used to evaluate the severity of ligament laxity; however, evaluating the accuracy of stress radiographs has led to conflicting results. Some studies have identified good agreement between stress radiographs and surgical findings,^{15,16} but others have concluded that stress radiographs only detected approximately half of ligamentous injuries.^{17,18} In addition, stress radiographs do not always demonstrate the severity of ligament injury.¹⁹ Conversely, use of magnetic resonance imaging (MRI) demonstrates high specificity and sensitivity in identifying lateral ankle ligament damage but has poor agreement with results from stress radiographs.²⁰ The benefit of MRI is that it provides a visual determination of the injury that is not made available by stress radiography. The disadvantage is that it is an expensive test and is often recommended only when surgical intervention is necessary.²¹

To help clinicians evaluate ligament laxity without using radiography, many joint arthrometers have been developed for the ankle. Examples of these arthrometers include the quasi-static anterior ankle tester (QAAT),^{22,23} dynamic anterior ankle tester (DAAT),²³ portable ankle arthrometer,^{12,24,25} ankle flexibility tester,^{26,27} and LigMaster.²⁸ To date, there are no published clinical uses of the QAAT and the DAAT. However, the portable ankle arthrometer and the LigMaster are available for both laboratory and clinical use. The current investigation used the LigMaster joint arthrometer. This apparatus is a modified version of the Telos. The modification includes an electronic sensor and software package that is connected to a computer to report displacement, stress, strain, and laxity of the joint. The computer interface allows the LigMaster to be used clinically without the need to concurrently perform stress radiographs. To date, no reliability information has been established for this device. Therefore, the purpose of this study was to establish intratester and intertester reliability of the LigMaster during both talar inversion and anterior drawer testing of the ankle.

Methods

Participants

Thirty participants (16 female, 14 male, 20.0 ± 1.5 years, 186.7 ± 10.8 cm, 73.6 ± 15.9 kg) were recruited from health, physical education, and recreation courses at a large Midwestern university. Participants were between the ages of 18 and 40 years. Exclusion criteria included any acute symptoms of an ankle injury, osteoporosis, or history of surgery or fractures to the lower extremity. History of previous orthopedic injuries was obtained using the Ankle Instability Instrument.²⁹ We purposely recruited a heterogeneous sample of people including people both with and without a history of ankle injuries. Sixteen (53%) of the 30 participants reported having a history of at least 1 ankle sprain. Of the injured participants, 9 (56%) reported unilateral ankle sprains, 7 (44%) reported sprains to both ankles, 4 (25%) had sustained a grade 1 or mild lateral ankle sprain, 7 (44%) reported grade 2 or 3 lateral ankle sprain, and 5 (31%) could not remember the exact classification of the ankle sprain. Using a heterogeneous sample allowed us to assess the repeatability of the LigMaster regardless of population tested. The university institutional review board approved the study, and informed consent was obtained for each participant.

Procedures

Data collection consisted of 2 days of testing in the athletic training research laboratory. Both the anterior drawer and the talar inversion tests were performed using the LigMaster joint arthrometer (Sport Tech, Inc, Charlottesville, VA) on both ankles. The LigMaster interfaced with a PC-compatible computer with Sport Tech software (version 1.35) for acquisition and processing of data. The order of test (the anterior drawer and talar inversion tests) and patient limb (right and left) were counterbalanced for all subjects. Two certified athletic trainers performed all testing. The clinicians had varying amounts of experience with the LigMaster. One had used the device for several years and the other had only a few months of previous experience. However, both clinicians tested more than 50 patients before the beginning of data collection. To assess intratester reliability, the more experienced clinician tested subjects on 2 separate days. To assess intertester reliability, both clinicians tested subjects on the same day (day 1).

Patient positioning was consistent with the manufacturer's recommendations. For the anterior drawer test, subjects were positioned side lying on the same side as the test ankle. The test knee was placed in 15° to 30° of flexion with the opposite leg flexed at the hip and knee. The heel of the ankle was placed in the ankle holder. The center of the pressure-actuator pad was placed against the skin 5 cm proximal to the medial malleolus for this test (Figure 1). The subject was instructed to relax and to not move the leg, foot, or toes during testing. A force of 150 N was applied to the joint, and the amount of displacement in millimeters was recorded.

During the talar inversion test, subjects were placed with the test leg extended and the heel in the testing device. The opposite leg was flexed at the knee and subjects were instructed to lean back onto their elbows. The heel of the ankle was placed in the ankle holder. The center of the pressure-actuator pad was placed against the skin at the most medial point of the medial malleolus (Figure 2).

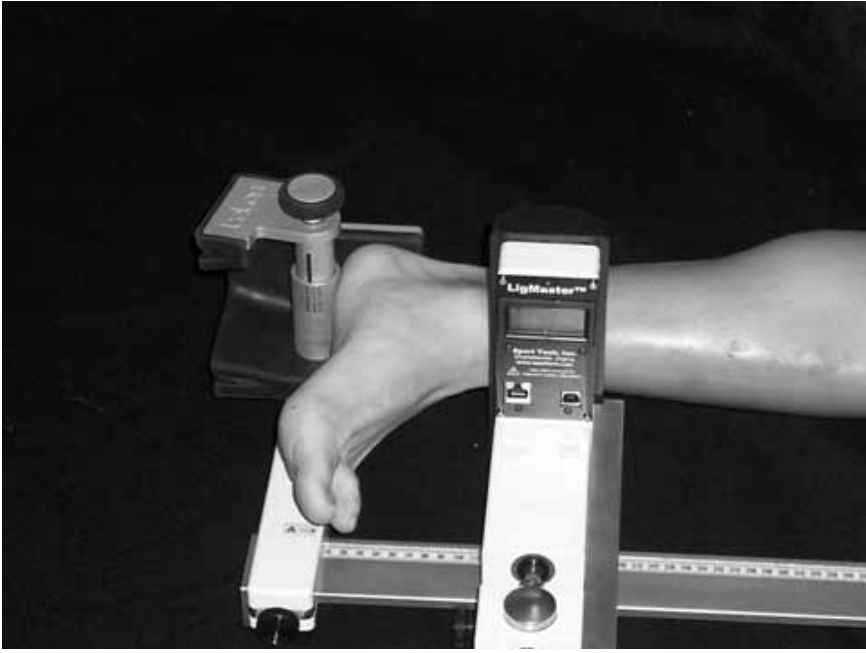


Figure 1 — Patient positioning for the anterior drawer test.



Figure 2 — Patient positioning for the talar inversion test.

Again, the subject was instructed to relax and to not move the leg, foot, or toes during testing. A force of 150 N was applied to the joint, and the amount of inversion in degrees was obtained. For both special tests, 1 practice trial was followed by 3 test trials. The practice trial was used to familiarize the participant with the testing device and answer any questions he or she had.

Statistical Analysis

The mean of the 3 test trials for each special test was used for statistical analysis. Intraclass correlation coefficients ($ICC_{2,k}$) and standard error of measurement (SEM) were calculated for intratester reliability and intertester reliability.³⁰ SEM was calculated as $SD \times$ the square root of $1 - ICC$. Intratester reliability compared the day-to-day reliability, and intertester reliability evaluated the reliability between 2 investigators. Interpretation of the reliability values was consistent with work done by Fleiss,³¹ who indicated that a value greater than .75 represents excellent reliability, values between .75 and .40 indicate good to fair reliability, and values less than .40 indicate poor reliability. It is important to note, however, that interpretation of the reliability coefficient varies depending on the nature of the variable or measure being evaluated. Some would argue that reliability must be equal to or greater than .9 to be classified as excellent.³²

Results

Means for the talar inversion test for investigator 1 were 28.85° ($SD = 3.98^\circ$) on day 1 and 30.69° ($SD = 4.24^\circ$) on day 2. For Investigator 2 the mean SD for the talar inversion test was 30.64° ($SD = 4.07^\circ$). For the anterior drawer test the means for investigator 1 were 20.01 mm ($SD = 3.72$ mm) for day 1 and 19.21 mm ($SD = 2.38$ mm) for day 2. For investigator 2 the mean for the anterior drawer test was 18.71 mm ($SD = 2.57$ mm). Intratester reliability was $.74$ ($SEM = 2.14^\circ$) for the talar inversion test and $.65$ ($SEM = 2.22$ mm) for the anterior drawer test. Intertester reliabilities for the talar inversion test and anterior drawer test were $.76$ ($SEM = 1.99^\circ$) and $.81$ ($SEM = 1.61$ mm), respectively.

Discussion

The primary finding of this study is that the LigMaster joint arthrometer is a reliable tool for measuring talar inversion and anterior displacement at the ankle. Reliability is present for both a single tester and between testers in assessment of ankle joint laxity. In addition, SEM values were relatively small, indicating good precision of measurement.

Evaluation of intratester reliability is important to determine changes in joint laxity over time. These changes might be the result of reinjury of the affected ligaments or treatment or rehabilitation of the ankle. Identifying a reliable measure of joint laxity will allow decisions to be made related to the effectiveness of treatment or rehabilitation, return-to-play criteria, or severity of reinjury. When evaluating each test individually, the talar inversion test has better reproducibility than the anterior drawer test ($.74$ versus $.65$), but both tests are within acceptable

ranges. Further investigation of the data provides additional support of the reliability of these measures. For the talar inversion test the difference between the means on the 2 days was approximately 2° . Similarly, for the anterior drawer test, the difference between the means on the 2 test days was less than 1 mm.

In addition, assessment of intertester reliability allows us to determine how different testers evaluate ligament laxity. This was a primary concern about using manual tests.⁸ Results of the current study indicate that, using the LigMaster joint arthrometer, different testers will obtain similar results. This is especially helpful when multiple clinicians are treating the same athlete or patient. Both the talar inversion and anterior drawer tests had good reproducibility. Further investigation of these data reveals that the mean differences between investigators was approximately 2° for the talar inversion test and 1 mm for the anterior drawer test.

Several studies have investigated the reliability of other ankle-joint arthrometers. Reliability of the DAAT and QAAT were established for anterior displacement,²³ and reliability of the portable ankle arthrometer was established for both anterior displacement and inversion–eversion motion.²⁵ Intrarater reliability of the DAAT ranged from .81 to .84 for the different examiners, and reliability for the QAAT ranged from .71 to .94.²³ Intrarater reliability for the portable ankle arthrometer was .91 for anterior displacement and .99 for inversion–eversion motion.²⁵ Interrater reliability for the DAAT ranged from .84 to .94 for the different examiners, and reliability for the QAAT ranged from .76 to .82.²³ Finally, the reported interrater reliability for the portable ankle arthrometer was .80 for anterior displacement and .98 for inversion–eversion rotation.²⁵ When comparing the reliability values of the LigMaster with those of the previously mentioned arthrometers, it is important to note that the LigMaster values were slightly lower. We can identify several reasons for these differences. First, the application of force differs between the various devices. Specifically, the portable ankle arthrometer used 125 N of force for anterior displacement and 4000 N-mm of torque for the inversion–eversion motion, and both the LigMaster and QAAT use 150 N for anterior displacement; the force used by the DAAT was not reported. Because different amounts of force or torque will create different amounts of joint movement,¹⁰ this factor makes it more difficult to directly compare these results. Second, the way the force application is created is very different for each of the devices. Both the portable ankle arthrometer and the QAAT create the force by the tester manually pulling on a handle. Because of this mechanism the rate of force application cannot be standardized. For the DAAT the examiner releases a hammer that strikes the calcaneus to produce the anterior force. The hammer travels at 1.7 m/s, but no actual force is reported. Finally, the LigMaster uses a threaded shaft that allows the examiner to slowly apply the pressure actuator to the joint. Even with slow application of force, the rate of loading is not standardized and could vary throughout the trial.

When one is trying to establish normative values using the LigMaster, these previously stated issues also play a role, especially when one is investigating inversion motion. For example, the portable ankle arthrometer actually reported inversion-to-eversion range of motion, so values ranged from approximately 55° to 59° .²⁵ Conversely, the LigMaster used the talar tilt test so only inversion motion was measured. Means for the current study ranged from 28° to 30° .

Although these differences might explain the range of reliability values reported in the literature, the results of this study allow us to conclude that the

LigMaster is a reliable tool. In addition, the portability and versatility of the LigMaster make it appropriate for both laboratory and clinical use. The LigMaster requires minimal setup. It comes in a portable carrying case and can easily be hooked up to any laptop or desktop computer. More important, the LigMaster is capable of testing the ankle in all directions. Although only inversion and anterior stress were studied in the current investigation, the LigMaster can also apply eversion stress. Therefore, it could potentially be used to test all ligamentous structures in the ankle. In addition, although beyond the scope of this article, the LigMaster can be used to test other joints in the body (ie, knee, elbow, shoulder). Future research should be conducted assessing the reliability of the LigMaster using fewer trials, as well as at other body joints.

One limitation of this study was our inability to quantify muscle activity during the special tests. With any type of ankle joint assessment, relaxation of the lower extremity musculature is important. Because this factor was not directly measured in this study, this could be a potential explanation for the slightly lower ICC values than in other studies.

Two subject-positioning issues should also be addressed. All subjects were positioned according to the LigMaster instruction manual, but because of inherent differences in their size and flexibility there were some problems. For example, in the anterior drawer test subjects were side lying with the contralateral hip and knee flexed and resting on the examination table. Some subjects lacked the flexibility to be comfortable in this position so a bolster was placed under the contralateral knee to keep them in the side-lying position. In addition, during the talar inversion test on a few subjects ($n = 3$) the heel slipped out of the ankle holder. This issue was addressed by cleaning both the holder and the subject's heel with alcohol. Although we do not think these issues affected our results, they are something that should be considered when using the device.

Conclusion

We assessed intratester and intertester reliability for the talar inversion and anterior drawer tests using the LigMaster joint arthrometer. We determined that both tests were reliable when testing on different days, as well as with different investigators. Therefore these measures could be used in the clinical setting when monitoring changes in ankle joint laxity.

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