Anterior Talocrural Joint Laxity: Diagnostic Accuracy of the Anterior Drawer Test of the Ankle

Lateral ankle sprains result from excessive ankle plantar flexion and inversion motions and are a common injury observed during competitive sports and military training. These injuries lead to pain, joint instability, persistent symptoms, and time lost that can impact unit readiness. Campbell et al. reported that the incidence of ankle sprain injuries in the United States military is 34.9 sprains per 1000 person-years at risk, which is 5 times higher than that in civilians. These injuries may lead to excessive stretching or tearing of the anterior talofibular ligament (ATFL) and/or calcaneofibular ligament, with subsequent talocrural or subtalar joint laxity.

Musculoskeletal care providers routinely examine talocrural joint integrity with the anterior drawer test (ADT) to identify the severity of anterior talocrural joint laxity in the acute setting, to advance clinical progression during rehabilitation, or to assign subjects to a research group on the basis of those joint examinations. Clinical examination tests used to determine ligament injuries of the ankle have demonstrated low reliability and diagnostic accuracy, which has subsequently limited their clinical utility and suggests that these clinical tests be interpreted with caution. Specifically, the diagnostic accuracy of the ADT to identify the presence of excessive anterior talocrural joint laxity has not been well established in the clinical setting. Clinicians and researchers should consider the purpose of this diagnostic test, which may be used to classify the injury, with the goal of selecting an effective intervention in accordance with evidence-based practice. The ADT presumably can be used to detect the presence of injuries to the anterior talocrural joint.

**STUDY DESIGN:** Prospective, blinded, diagnostic-accuracy study.

**OBJECTIVES:** To investigate the diagnostic accuracy of the ankle anterior drawer test (ADT) to detect anterior talocrural joint laxity in adults with a history of lateral ankle sprain.

**BACKGROUND:** The ADT is used to manually detect anterior talocrural joint laxity following lateral ankle sprain injury; however, the diagnostic accuracy of this test has not been established.

**METHODS:** Sixty-six subjects with a history of lateral ankle sprain were examined with the ADT. Anterior talocrural joint laxity was measured digitally from ultrasound images of the talofibular interval during performance of the ADT. In addition, anterior talocrural joint laxity was measured digitally in 20 control subjects to establish a reference standard. ADT results were defined as “positive” or “negative,” based on this and a second reference standard established from the literature.

**RESULTS:** The group with a history of lateral ankle sprain had a mean ± SD anterior talocrural joint laxity of 3.36 ± 3.25 mm, compared with 0.17 ± 1.87 mm in the control group. Thirty-five of 66 (53%) subjects demonstrated anterior talocrural joint laxity at a reference standard of 2.3 mm or greater, and 24 (36%) at a reference standard of 3.7 mm or greater. Sensitivity of the ADT was 0.74 (95% confidence interval [CI]: 0.58, 0.86) and 0.83 (95% CI: 0.64, 0.93) at the 2.3 mm or greater and 3.7 mm or greater reference standards, respectively. Specificity of the test was 0.38 (95% CI: 0.24, 0.56) and 0.40 (95% CI: 0.27, 0.56), respectively. Positive likelihood ratios were 1.2 and 1.4, whereas the negative likelihood ratios were 0.66 and 0.41, respectively.

**CONCLUSION:** The ADT provides limited ability to detect excessive anterior talocrural joint laxity; however, it may provide useful information when used in side-to-side ankle comparisons and in conjunction with other physical exam procedures, such as palpation.

**LEVEL OF EVIDENCE:** Diagnosis, level 3b.


**KEY WORDS:** instability, sensitivity, specificity, ultrasound imaging

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**Footnotes:**

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push on the tibia and attempting to in or rule out talocrural joint anterior laxity. Specificity of the test are helpful in determining the ADT’s ability to rule in or rule out talocrural joint anterior laxity, LRs mathematically combine both. Clinically, a +LR greater than 10, given a positive test result, is considered to generate a conclusive shift in probability of the injury being present. Conversely, a –LR less than 0.1, given a negative test result, generates a large shift in posttest probability of the absence of injury.

The diagnostic accuracy of tests like the ADT can be determined by computing sensitivity, specificity, positive likelihood ratios (+LRs), and negative likelihood ratios (–LRs). While the sensitivity and specificity of the test are helpful in determining the ADT’s ability to rule in or rule out talocrural joint anterior laxity, LRs mathematically combine both. Studies have shown that the diagnostic accuracy of tests like the ADT can be enhanced by using a combination of signs and symptoms, such as the formation of a hematoma, location of pain, palpation, and the results of the ADT, with arthrography used as the gold standard. No study, to our knowledge, has reported on the diagnostic accuracy of the ADT when compared to a reference standard of anterior talocrural joint laxity.

The diagnostic accuracy of tests like the ADT can be determined by computing sensitivity, specificity, positive likelihood ratios (+LRs), and negative likelihood ratios (–LRs). While the sensitivity and specificity of the test are helpful in determining the ADT’s ability to rule in or rule out talocrural joint anterior laxity, LRs mathematically combine both. Clinically, a +LR greater than 10, given a positive test result, is considered to generate a conclusive shift in probability of the injury being present. Conversely, a –LR less than 0.1, given a negative test result, generates a large shift in posttest probability of the absence of injury.

The ADT, performed with the ankle in 10° to 20° of plantar flexion and the subject relaxed, requires the clinician to stabilize the distal leg and grasp the calcaneus to impart an anteriorly directed force to the foot and ankle complex, in an attempt to move the talus in an anterior direction relative to the distal end of the lower leg. The clinician attempts to visually and manually sense the quantity of talar movement and to determine if an asymmetry exists between the involved and uninjured ankle. Variances in hand position, scoring methods, forces imparted, joint congruency, tissue variability, and perception of movement are factors that may affect reliability of the ADT. Gould et al suggested that ankle injuries that elongate the ATFL by more than 4 mm or 20% of its original length might cause the ligament to fail and likely produce a positive ADT. Lähde et al found that 28% of ATFL tears and 38% of combined ATFL and calcaneofibular ligament tears were not detected using the ADT. Furthermore, negative clinical ankle tests and stress radiography examinations are not indicative of an absence of ankle ligament pathology.

Nyska et al used stress radiography to examine the magnitude of anterior talocrural joint movement to establish the concurrent validity for the ADT to detect increased anterior talocrural joint laxity. Measurements in 25 subjects with recurrent ankle instability indicated anterior talar movement of 0.2 ± 0.8 mm (corresponding to grade 0, no movement), 2.0 ± 0.8 mm (corresponding to grade 1, slight movement), and 2.3 ± 1.1 mm (corresponding to grade 2, significant movement). Those findings are similar to the 2.3-mm average increase in anterior talocrural joint laxity observed across several in vitro ligament-sectioning studies. Nyska et al did not report the specificity, sensitivity, or LRIs of the modified ADT results, information that would help clinicians better evaluate the diagnostic utility of the ADT.

The purpose of the current study was to prospectively investigate the diagnostic accuracy of the clinical ADT against a reference standard of measurement of sagittal plane talar movement resulting from a standardized anterior drawer force and captured on a series of ultrasound images. The secondary purpose was to determine the extent to which the ADT assists clinicians in altering the probability that abnormal talocrural joint laxity is present given either a positive or negative test, as established by 2 specific reference standards.

### Methods

**Individuals with a History of Lateral Ankle Sprain**

Individuals with a history of lateral ankle sprain were recruited between September 2009 and December 2010 via flyers and electronic mail, and from emergency room personnel and the local university population. Individuals...
were included, based on their history of lateral ankle sprain, to reflect a population that would be expected to undergo testing with an ADT if presenting to a clinician with symptoms of ankle pain and instability or for a preparticipation physical examination.

Potential subjects completed the modified Ankle Instability Instrument. If they reported a history of ankle sprain on this questionnaire, they were considered for inclusion. Subjects were included if, on further questioning, they confirmed that the injury or injuries experienced were lateral ankle sprains from a plantar flexion/inversion-type movement. Subjects varied in the number of ankle sprains, the time since the last ankle sprain, the self-reported function of the ankle, and symptoms (Table 1). Subjects included in the study were considered ankle sprain copers, having chronic ankle instability, or having had an acute ankle sprain.

Subjects were excluded if they had a history of ankle surgery or ankle fracture, reported a mechanism of injury other than a plantar flexion/inversion-type event, or had broken skin around the foot/ankle region that would limit ultrasound scanning. Subjects were also excluded if, during the physical or ultrasound examination, findings were observed that were not consistent with a history of a lateral ankle sprain. For subjects with acute ankle sprains, data were collected a mean ± SD of 5.9 ± 4.5 days after the injury. Subject demographics are provided in Table 1.

Anterior talocrural joint laxity was evaluated against 2 reference standards. The first reference standard was anterior talocrural joint laxity equal to or greater than 2.3 mm, as per the work of Kerkhoffs et al, who determined, based on 9 cadaveric studies, that on average there was a 2.3-mm increase in anterior laxity when the ATFL was cut. The second reference standard of 3.7 mm or greater was based on data collected on 20 healthy participants who were free from any history of ankle injury or reports of instability and were recruited specifically for the control group. This group was similar in age, height, and mass to the injured group and underwent the same ultrasound-imaging protocol as the injured group; however, control-group data were not used to calculate diagnostic accuracy. The ankle entered into the analysis was chosen randomly after a preliminary analysis demonstrated no significant within-subject differences between limbs on the dependent variable of interest. The 3.7-mm value was equal to twice the magnitude of the standard deviation of the control-group anterior laxity values.

All subjects gave written informed consent, and the study methods were approved by the University of Virginia Institutional Review Board for Human Subjects Research. Each subject was financially compensated for study participation. After screening, the subjects completed the Foot and Ankle Ability Measure activities of daily living and sports subscales. The Foot and Ankle Ability Measure is a self-reported disability scale consisting of a 21-point activities of daily living portion and an 8-point sports subscale. The assessment has test-retest reliability of 0.89 and 0.87 for the 2 subscales, respectively.

Data were collected in a prospective fashion, with the ADT performed in a seated position. The clinician stabilized the distal part of the leg with 1 hand and applied an anterior force to the calcaneus with the other hand (Figure 1), consistent with the method described by van Dijk et al and for which Bahr et al provided supporting evidence. The clinician graded the amount of talocrural joint anterior motion according to a 0-to-4 ordinal scale, with grade 0 as hypomobile, 1 as normal, 2 as mild increased laxity, 3 as moderate increased laxity, and 4 as severe increased laxity. In the first analysis, grades of 2 and above were considered “positive” for excessive laxity, whereas grades of 0 or 1 were considered “negative” or normal. In a second analysis, clinician-assessed grades of 3 and above were considered positive for excessive laxity. The examiner was not blinded to the subject’s injury history at the time of the clinical examination. The examiner who performed all clinical tests and ultrasound examinations was a physical therapist who had 13 years of clinical experience, with 9 years experience as a board-certified orthopaedic clinical specialist and 4 years experience in ultrasound imaging.

Ultrasound imaging was performed immediately following the ADT with a LOGIQ Book Pro portable ultrasound unit (GE Healthcare, Waukesha, WI), using a 38-mm linear-array transducer probe operating at 10 MHz and scanning at a depth of 30 mm. Digital images were stored as JPEG files for later measurement. During the ultrasound imaging, a LigMaster multijoint arthrometer (Sport Tech, Inc, Charlottesville, VA) was used to apply 125 N of posteriorly directed force to the tibia, while the heel was blocked to prevent motion of the calcaneus and foot. This was a modified stress device (GA II/E; Telos GmbH, Marburg, Germany) that provided a real-time visual force display.

Instrumented testing of ankle laxity was performed with the subject in a sidelying position, with the tested ankle resting on a 50 × 50 × 12-cm box. The ankle was in a neutral position (0° of plantar flexion and 0° of inversion) and the knee in approximately 15° to 20° of flexion. The examiner palpated the lateral malleolus and talus, then applied ultrasound conducting gel directly over the ATFL area prior to application of the ultrasound probe. The examiner applied the probe to the lateral ankle and oriented the lateral malleolus to the right side.
of the viewing screen, then identified the lateral talar cartilage and the neck of the talus where the ATFL attaches. After optimizing the image and centering the image within the field of view, the examiner saved the image to a file for later analysis and removed the probe. The subject was then instructed to plantar flex and dorsiflex the ankle 3 times, and again reposition the ankle in neutral, at which point the ultrasound examination was repeated. The process was repeated a third time to obtain and save 3 images.

Ultrasound imaging during mechanical testing was performed with the subject in sidelying, with the medial aspect of the heel resting on the immobile heel-block component of the LigMaster arthrometer, similar to the methods used by Docherty and Rybak-Webb.\textsuperscript{12} The head of the device, instrumented with a force transducer, was adjusted to a position 3 cm proximal to the distal tibia, and a posteriorly directed force of 125 N was applied as shown by Croy et al.\textsuperscript{9} While under stress, the lateral malleolus and talus were imaged in similar fashion, as previously described, then the stress was released back to 0 N. This sequence was also repeated to obtain 3 images.

Ultrasound images were subsequently transferred to a standard laptop computer, then measured several days later with ImageJ software (National Institutes of Health, Bethesda, MD).\textsuperscript{16} At the time of measurement, the examiner was blinded to the subject’s history, the results of the manually performed ADT, the amount of force applied by the arthrometer (0 or 125 N), and the results of the talofibular-interval measurement. Each ultrasound image had a field of view of 13.3 × 10.8 cm and 521 × 412 pixels. A digital caliper was used to standardize the linear measurement to 13.8 pixels per mm for all images. The measurement reliability for these methods ranges from 0.77 to 0.91 between examiners and 0.93 to 0.96 for a single examiner.\textsuperscript{40} These methods were similar to those used by Brasseur et al\textsuperscript{2} and Glaser et al\textsuperscript{17} that have been published previously.\textsuperscript{9,40}

To calculate the anterior laxity difference scores, digital calipers were used to manually draw a straight line between the anterolateral aspect of the lateral malleolus and the peak of the talus, just anterior to the lateral talar articular cartilage. These 2 bony landmarks appear hyperechoic on the ultrasound image and correspond to the anatomical locations of the origin and insertion of the ATFL in this imaging plane.\textsuperscript{2,7,10,40} The region of the viewing screen, then identified the anterolateral aspect of the lateral talus were imaged in similar fashion, as previously described, then the stress was released back to 0 N. This sequence was also repeated to obtain 3 images.

The frequency distribution of these new variables, along with the grades from the ADT, was then cross-tabulated to calculate the diagnostic accuracy of the ADT. A box-and-whisker plot was used to depict the quartile ranks for the ankle-injured cohort and the control group on the dependent variable of anterior laxity, measured with the arthrometer at 125 N of force. The Spearman rho was used to determine the relationship between the grades of anterior laxity given with the manually performed ADT and the anterior laxity difference scores calculated from the ultrasound images for each of the 3 ankle-injured subsets (ankle sprain copper, chronic ankle instability, acute ankle pain) that comprised the ankle-injured group. Correlations were considered significant at the $P<.05$ level, and the hypothesized null relationship between the laxity grades and the anterior difference scores was $\rho = 0$.

The diagnostic accuracy of the manually performed ADT, based on the 2.3- and 3.7-mm thresholds determined with mechanical testing, was subsequently determined by calculating sensitivity, specificity, +LR, and −LR with 2-by-2 contingency tables. The pretest probability of excessive anterior talocrural joint laxity was set a priori at 50%, and changes in posttest probability were
to enroll. In addition, 2 subjects were excluded after abnormality of the lateral malleolus or talus was identified on ultrasound imaging, which warranted referral to a primary-care physician, and 1 subject was excluded for clinical signs of a deltoid ligament injury. A total of 66 subjects with a history of lateral ankle sprain were included in the study and received the index and reference tests (FIGURE 3). Nineteen subjects were categorized as ankle sprain copers, 25 subjects were categorized as having chronic ankle instability, and the remaining 22 subjects were considered to have an acute lateral ankle sprain. Subject demographics for the control and ankle-injured groups are shown in TABLE 1. Participants consisted of 35 (53%) males and 31 (47%) females in the ankle-injured group and 12 (60%) males and 8 (40%) females in the control group. No adverse events were associated with testing.

The mean ± SD anterior laxity measured when applying 125 N of force with the arthrometer was 3.36 ± 3.25 mm for the ankle-injured group (n = 66) and 0.17 ± 1.87 mm for the controls (n = 20). Only 1 subject (5%) in the control group had laxity greater than both specified thresholds (2.3 and 3.7 mm). FIGURE 4 demonstrates the quartile values for the ankle-injured group and the control group. There was a moderately strong correlation between the clinical grades of laxity given with the manually performed ADT and the amount of anterior laxity measured from the ultrasound images for the group with an acute ankle sprain (rho = 0.62, P = .002). No significant relationship was observed between these 2 variables for the copers (rho = −0.11, P = .67) or those with chronic ankle instability (rho = 0.10, P = .62).

The ADT had good sensitivity for the assessment of sagittal plane talocrural instability; however, the test was found to have poor specificity at both reference standards. The 95% CIs of the +LR and −LR calculated at the reference standard of 2.3 mm or greater and the −LR calculated at the reference standard of 3.7 mm or greater included the null value of 1. The 95% CI for the +LR calculated at the reference standard of 3.7 mm or greater was the only confidence interval that did not contain the null value of 1. The diagnostic-accuracy statistics for the ADT appear in TABLES 2 and 3. Full 2-by-2 contingency tables for the ADT results compared to the 2 reference standards are provided in TABLE 4.

**RESULTS**

SEVENTY-SEVEN POTENTIAL PARTICIPANTS were recruited and screened for clinical and ultrasound examination. Eight individuals were excluded from participation prior to consent: 5 who had a time of 14 or more days since their acute ankle injury and 3 who declined determined using the +LRs, −LRs, and a nomogram. A +LR with a 95% confidence interval (CI) that did not contain the null value of 1 was considered significant at the P < .05 level.

The primary finding of the current study was that the ADT demonstrated low diagnostic accuracy when evaluated against 2 reference stan-
Excessive anterior talocrural joint laxity, given a positive ADT result, would be considered important, while a negative test result would be considered unimportant, and insignificant shifts in posttest probability that the individual with a lateral ankle sprain will not demonstrate excessive anterior talocrural joint laxity. The diagnostic accuracy of the ADT was evaluated based on 2 reference standards from the best evidence in the literature and established with standards of anterior talocrural joint laxity. Positive ADT results may lead to small, unimportant, and insignificant shifts in the posttest likelihood of excessive anterior talocrural joint laxity, given a positive test result. Similarly, a negative test result may only generate small changes in the posttest probability that the individual with a lateral ankle sprain will not demonstrate excessive anterior talocrural joint laxity. Moreover, these reference standards were applied on subjects who were representative of the population in which the ADT would be used clinically. Our results exceed those previously reported by Nyska et al, who used stress radiography to measure tibiotalar motion and found anterior talocrural joint laxity ranging from 0.2 (no movement) to 2.3 mm (significant movement) in subjects with recurrent ankle sprains of a similar age to those in the present study. Unlike Nyska et al, we only observed a significant positive association between the clinical grades of laxity determined with the ADT and the amount of anterior laxity measured with the arthrometer in the group with acute lateral sprains. Caputo et al also identified only a slight amount of anterior talar translation (0.2–0.4 mm) in control ankles, in contrast to a significant amount of anterior translation (0.9 ± 0.6 mm) in individuals with chronic ankle instability, when measured in weight bearing using a 3-D magnetic resonance imaging and orthogonal fluoroscopic imaging method. Hubbard documented a 5.5-mm increase in anterior ankle laxity following acute ankle sprain and also indicated that perceptible anterior laxity and symptoms of instability may persist for more than a year following an ankle sprain. Mechanical laxity, as well as hypomobility, at the talocrural joint is an important component of ankle instabil-

### TABLE 2

<table>
<thead>
<tr>
<th>Reference Standard</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>+LR</th>
<th>–LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3 mm or greater</td>
<td>0.74 (0.58, 0.86)</td>
<td>0.38 (0.24, 0.56)</td>
<td>1.21 (0.86, 1.70)</td>
<td>0.66 (0.32, 1.36)</td>
</tr>
<tr>
<td>3.7 mm or greater</td>
<td>0.83 (0.64, 0.93)</td>
<td>0.40 (0.27, 0.56)</td>
<td>1.40 (1.03, 1.90)</td>
<td>0.41 (0.16, 1.08)</td>
</tr>
</tbody>
</table>

Abbreviations: –LR, negative likelihood ratio; +LR, positive likelihood ratio. *Test results equal to grade 2 above were considered positive for anterior talocrural joint laxity, and results below that were considered negative. Values in parentheses are 95% confidence interval.

### TABLE 3

<table>
<thead>
<tr>
<th>Reference Standard</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>+LR</th>
<th>–LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3 mm or greater</td>
<td>0.26 (0.14, 0.42)</td>
<td>0.67 (0.50, 0.81)</td>
<td>0.79 (0.37, 1.74)</td>
<td>1.09 (0.80, 1.49)</td>
</tr>
<tr>
<td>3.7 mm or greater</td>
<td>0.33 (0.18, 0.53)</td>
<td>0.73 (0.59, 0.85)</td>
<td>1.27 (0.59, 2.72)</td>
<td>0.90 (0.64, 1.26)</td>
</tr>
</tbody>
</table>

Abbreviations: –LR, negative likelihood ratio; +LR, positive likelihood ratio. *Test results equal to grade 3 above were considered positive for anterior talocrural joint laxity, and results below that were considered negative. Values in parentheses are 95% confidence interval.
ity, and thorough evaluation of the inferior tibiofibular, talocural, and subtalar joints is necessary to develop effective therapeutic treatments.47

Forty-five of our subjects demonstrated a positive ADT (grade 2 or higher when assessed manually); however, 42% and 56% of those would be considered false positive tests, based on anterior laxity values during mechanical testing of less than 2.3 or 3.7 mm, respectively. This large number of false positives may be due to an inaccurate perception of foot and ankle movement during the test. During the ADT, the clinician loads the ankle joint through the calcaneus and creates anterior movement of the talus via the subtalar joint,48 a phenomenon observed and measured with stress radiographs of the ankle.49 However, lateral ankle sprains can result in damage to the ATFL, the calcaneofibular ligament, and other stabilizers of the subtalar joint, which may confound the interpretation of movement felt during the ADT. Hertel et al21 identified 7 subjects with increased laxity when performing the ADT, of whom only 3 had isolated talocural joint laxity, with the other 4 demonstrating a pattern of combined talocural and subtalar joint injuries. The ultrasound methods in the present study were used to image only the talocural joint and then used to quantify anterior talocural joint laxity, and therefore could not have been influenced by excessive subtalar motion.

The LR derived based on both reference standards indicated that a negative ADT (grade 2 or lower) on clinical examination may generate, at best, small, some-

TABLE 4

Two-by-Two Contingency Tables for the 2 Reference Standards Used to Evaluate the Anterior Drawer Test Using the Ankle-Injured Cohort Only*

<table>
<thead>
<tr>
<th></th>
<th>ADT Result</th>
<th>2.3-mm or Greater Laxity</th>
<th>Less Than 2.3-mm Laxity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 or greater, positive</td>
<td>26</td>
<td>19</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Less than 2, negative</td>
<td>9</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35</td>
<td>31</td>
<td>66</td>
</tr>
<tr>
<td>B</td>
<td>3.7-mm or Greater Laxity</td>
<td>20</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Less than 3, negative</td>
<td>4</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24</td>
<td>42</td>
<td>66</td>
</tr>
<tr>
<td>C</td>
<td>3 or greater, positive</td>
<td>9</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Less than 3, negative</td>
<td>26</td>
<td>21</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35</td>
<td>31</td>
<td>66</td>
</tr>
<tr>
<td>D</td>
<td>3.7-mm or Greater Laxity</td>
<td>8</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Less than 3, negative</td>
<td>16</td>
<td>31</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24</td>
<td>42</td>
<td>66</td>
</tr>
</tbody>
</table>

Abbreviation: ADT, anterior drawer test.

*The ADT was considered positive for scores 2 and above (A and B) and positive for scores 3 and above (C and D).

ing symptoms of pain or instability.6 Individuals who report both a history of ankle sprain and instability symptoms but do not demonstrate laxity have been categorized as functional ankle instability,6 with the origins of instability symptoms attributable to impairments in postural control, joint proprioception, and neuromuscular control of the ankle joint,20,23 rather than to mechanical instability resulting from ligament injury. Takao et al42 reported that all 14 subjects who had ankle instability symptoms but less than 6 mm of anterior talocural joint laxity from stress radiographs had arthroscopically demonstrable morphologic changes in ATFL anatomy and required ligament reconstruction. Twelve of 66 (18%) of our subjects with ankle sprains (7 acute injuries, 3 chronic ankle instability, and 2 copers) demonstrated anterior talocural laxity greater than 6 mm, whereas, similar to the data by Takao et al,42 the remaining 54 (82%) demonstrated less than 6 mm of anterior laxity.

This study is limited in several areas. We graded the amount of movement perceived during the manual application of the ADT on an ordinal scale (0–4), then dichotomized scores of 0 and 1 as negative and 2 and above as positive to evaluate diagnostic accuracy, similar to methods used by clinicians.29 A further analysis of the data using clinician assessment of grade 3 and above as positive yielded LR results that were poorer. We did not evaluate the level of reliability of the laxity grades assigned by the clinician who performed the ADT, and only 1 clinician examined the subjects, which may limit the generalizability of the findings. To minimize expectation bias, the test procedures were standardized and the examiner was blinded to the ADT results.
when measuring the ultrasound images. An involved-to-uninvolved ankle comparison, as commonly performed during a clinical examination, was not included, as this would have required 2 separate judgments of anterior displacement. We measured neither the angulation of the talus, a common measurement in stress radiography, nor tibiotalar movement, a more common method of evaluating ankle laxity with imaging studies. The morphological appearance of the ATFL was not considered in this study because, although it is an established technique to identify ligament injury, it could have introduced expectation bias. However, ligament appearance did vary among subjects. The present study was limited to the application of ankle stress and quantified displacement of the talus relative to the fibula assessed on an ultrasound image of the involved ankle alone and did not include a side-to-side comparison, as is standard in orthopaedic physical therapy practice. Measurement error might also have contributed to the misclassification of the anterior talocrural joint laxity data. The ADT may still have diagnostic value to identify injury based not only on laxity but also on reproduction of pain, perception of resistance, and comparison to the uninvolved ankle. Alterations in fibular position as well as talar internal rotation and anterior displacement, which were not measured in this study, may explain the changes in the relative position of the bony landmarks.

We evaluated the laxity grade given with manual performance of the ADT against 2 standards of anterior talocrural laxity. The first standard was derived from the work of Kerkhoffs et al and represents the results of 9 in vitro ligament-sectioning studies specifically designed to measure changes in talar motion in response to simulated ATFL injuries. Fifty-three percent of the subjects with ankle injuries in the current study demonstrated at least 2.3 mm of anterior talocrural joint laxity. van Dijk et al used a 2-mm minimum standard of anterior laxity between involved and uninvolved ankles, as measured on stress radiographs, in a clinical study of subjects with ankle instability. The second reference standard for laxity was 3.7 mm or greater and represented twice the standard deviation of the displacement values measured on our control subjects (SD, 1.87 mm), who reported no history of ankle injury or symptoms of instability. Twenty-six percent of subjects with ankle injuries demonstrated anterior laxity greater than 3.7 mm. This threshold was chosen because it allowed us to demonstrate changes from an uninjured control group rather than solely in comparison to studies using different methods and involving both patients and cadavers. This threshold is similar to that used by Abbott et al, who evaluated manual assessment of segmental spinal mobility, for which no gold standard exists. The 3.7-mm threshold is also similar to the 4-mm upper standard of anterior laxity used by van Dijk et al, who used radiographic bony landmarks on the tibia and talus to identify talar movement resulting from anterior drawer stress, similar to other investigations. Unlike previous investigations, our study utilized ultrasound to image the talocrural joints of a wide spectrum of subjects with a history of lateral ankle sprains, with and without stress applied, and calculated mean increases in anterior talocrural joint laxity. These methods do not expose the examiner, or the subject, to ionizing radiation and appear to demonstrate similar absolute changes in talar position as in vitro studies of cadaver ankles and stress radiographic studies of subjects with ankle instability.

The amount of movement of the talus, when tested with the arthrometer, in 50% of our subjects with a history of ankle injury was between 1 and 5 mm, whereas the laxity of the ankle for those in the control group was less than 1 mm. The threshold for significant movement, based on cadaver studies and the current study, appears to be approximately 2.3 mm, with the majority (53%) of injured ankles exceeding this laxity threshold. Forty-seven percent of ankle injuries did not exceed the 2.3-mm threshold, indicating that laxity is only one of several physical impairments to consider in a patient following lateral ankle sprain.

CONCLUSION

The clinical assessment of talocrural joint anterior laxity using the ADT, whether the test is considered positive or negative, does not result in meaningful change in the pretest likelihood that an individual with a history of an ankle sprain will or will not demonstrate excessive anterior talocrural joint laxity. These findings improve our understanding of the diagnostic accuracy of this common physical examination test and suggest the use of alternative methods of assessment, such as ultrasound imaging.

KEY POINTS

FINDINGS: The ankle ADT has limited diagnostic accuracy for detecting excessive anterior laxity in subjects with a history of lateral ankle sprains.

IMPLICATIONS: The ankle ADT should be considered as a screening test in the assessment of lateral ankle sprain and suspected ATFL injury; however, clinicians should interpret the diagnostic test results with caution and consider alternative assessment methods, such as ultrasound or radiographs, when accurate assessment of laxity is required.

CAUTION: Changes in the talofibular interval were used to evaluate the ADT; however, most studies of laxity use the tibia as the fixed reference point and not the fibula. Assessment of laxity was made based on the amount of displacement of the involved ankle and did not include a comparison with the contralateral ankle.

REFERENCES


