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Clinical evaluation of a dynamic test for lateral ankle ligament laxity

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Abstract The dynamic anterior ankle tester (DAAT) has shown a good reliability in testing anterior talar translation in earlier studies. The goal of the present study was first to evaluate the reliability of the DAAT in a clinical setting and second to analyze its ability to detect increased ligament laxity. In 39 patients with unilateral chronic lateral ankle instability, the anterior talar translation of the affected and non-affected side was measured pre and postoperatively using the DAAT, Telos stress radiographs, and the manual anterior drawer test. In contrast to both other tests, the DAAT was not able to accurately detect increased ligament laxity preoperatively or decreased laxity of the affected ankle postoperatively. The DAAT showed a low sensitivity to change (the difference between the mean pre and postoperative value) and a low reliability compared to both other tests. There were no correlations between the three tests. In conclusion, the DAAT showed a low reliability in effectively testing lateral ankle ligament laxity in a clinical setting. This is in contrast to earlier evaluations.

Keywords Ankle · Lateral ligaments · Laxity · Reliability

Introduction

Chronic giving way symptoms in combination with increased lateral ligament laxity develop in ten to twenty percent of the patients sustaining an ankle inversion injury [14]. If conservative measures fail, anatomical reconstruction of the lateral ankle ligament complex provides a good treatment for these patients [1].

The anterior drawer test is the most appropriate clinical test for evaluation of lateral ankle ligament laxity [19]. The manual anterior drawer test is easy to apply but is subjective in nature, and the high intra- and inter-observer variation limits its use, especially for research purposes [7, 21]. Several (radiological) instrumented tests have been developed for objective measurement of ankle instability [19, 20, 32]. Ankle stress radiographs using a Telos stress apparatus is probably the best known and widely used for clinical and scientific evaluation [11, 13, 24, 26]. All these tests have the disadvantage of applying a constant force when testing ankle ligament laxity, allowing for false negative results due to apprehensive muscle contractions and with radiographic stress testing patients are exposed to radiation [16].

Avoiding radiation exposure and to overcome the influence of involuntary muscle contractions on the outcome of an anterior drawer test, the dynamic anterior ankle tester (DAAT) was developed to objectively assess lateral ankle ligament laxity [16, 17]. Its reliability and reproducibility were evaluated on cadaver ankles, healthy subjects, and subjects with known increased ligament laxity [16, 17]. These laboratory studies showed that of the original two parameters, the anterior talar translation is a reliable and reproducible measure with a good intra- and inter-observer reliability, whereas the talar rotation is not.
In a recent prospective study, the clinical outcome of arthroscopic capsular shrinkage for chronic lateral ligament instability of the ankle was evaluated [5]. Postoperatively, both improved functional stability and manually and radiographically tested reduced ligament laxity were found.

The goal of the present study was to clinically evaluate the reliability of the DAAT and its ability to detect increased ligament laxity of an affected ankle joint and the mechanical effect of the shrinkage procedure. Outcome of the DAAT was compared to the manual anterior drawer test and the radiographically measured anterior talar translation. The hypothesis was that the DAAT would prove to be at least as reliable as or have a better reliability than both the manual and radiographic stress test in assessing lateral ankle ligament laxity.

**Patients and methods**

**Design**

The study was designed as a prospective longitudinal, intra- and inter-test comparative diagnostic trial. Anterior talar translation in patients with chronic lateral ankle instability scheduled for ankle ligament shortening (arthroscopic capsular shrinkage) was preoperatively and postoperatively measured using the DAAT (D-ATT), ankle stress radiographs (R-ATT), and the manual anterior drawer test (M-ATT). The study period was from February 2002 to February 2005. The Medical Ethical Committee of the hospital approved the study. The clinical results of the arthroscopic capsular shrinkage procedure have been published earlier [5].

**Patients**

Inclusion criteria were patients older than 18 years of age with recurrent sprains, giving way, and ligament laxity for more than 6 months, who were able to give informed consent. Thirty-nine patients (19 male, 20 female; 16 right ankles, and 23 left ankles) were included. The median age at the time of operation was 27 years (range: 18–66). No patients were lost to follow-up, but one female patient did not allow performing the DAAT and ankle stress radiographs at follow-up because of expected pain.

Increased ligament laxity was defined as anterior talar translation (ATT) ≥ 4 mm or a difference with the contralateral side ≥ 3 mm [12, 13, 24, 27]. Additional exclusion criteria were previous operative therapy for chronic ankle instability, constitutional hyper laxity, systemic diseases affecting the locomotor, system and osteoarthritis grade II or III [34].

**Instrumentation**

**The dynamic anterior ankle tester**

The test device has been previously described [16, 17, 34]. The anterior talar translation of the DAAT is measured as the anterior displacement of the talus relative to the tibia in millimeters (D-ATT, millimeters). The subject is seated on a chair with the hip flexed. The foot is placed on a horizontal slide with the back of the heel against a vertical ledge with the hindfoot fixated in a clip. The shin of the tibia is placed against and strapped to a frame which makes an angle with the horizontal, such that the knee is flexed, and the foot is in 15° of plantar flexion. This simulates the optimal position to perform the manual anterior drawer test. The frame prevents anterior displacement and sagittal rotation of the tibia. A 1-kg hammer is placed horizontally and then released with a snap connection. The hammer hits the horizontal slide posterior of the foot and thereby the calcaneus with a velocity of 1.7 m/s. The anterior movement, reflecting the ATT, is measured by a potentiometer. The 35 ms the test takes is within the muscle reflex time [8, 35]. A peak and hold amplifier keeps the highest signal of both potentiometers. The signal is transformed into millimeters and degrees, respectively, and the values can be read from a display. The intrinsic accuracy of the D-ATT with respect to the measured values is 0.1 mm.

**Ankle stress radiographs**

Radiographic anterior talar translation (R-ATT, millimeters) was measured on lateral ankle views using the Telos GAII/E stress device (ARD Medizin Produkte GmbH, Germany). Radiographs were taken in neutral position and with 150 Newton stress-force. The R-ATT was measured as the difference in anterior displacement of the talus relative to the tibia (shortest distance between the posterior lip of the tibia and the talus) in neutral and in stressed situation [2].

**Manual anterior drawer test**

The manual anterior drawer test is performed with the patient sitting on a bench with the legs hanging downwards, such that the knee joint is in 90° of flexion; the foot held in 15° plantar flexion. First, the healthy ankle is examined, followed by the affected ankle [33]. The examiner assigned one of four predetermined categories to each examined ankle joint, based on the estimated anterior displacement of the talus relative to the tibia: 0 = 0–2 mm; 1 = 3–5 mm; 2 = 6–10 mm; 3 = 11–15 mm. Hereafter, the manual anterior drawer test will be referred to as manual-ATT (M-ATT, categories).
Procedure

Preoperative and 6-month postoperative, the anterior talar translation of the affected and non-affected ankle was measured manually (M-ATT), radiologically (R-ATT), and with the DAAT (D-ATT). For the D-ATT, the test was repeated five times per side per session with the patient remaining in position. The highest and lowest results of these five measures were discarded, whereas the mean of the three remaining results was taken as the final result per side per session [16]. Both other tests were performed once per side per session.

Statistical analysis

Outcome measures were the preoperative difference between the affected and non-affected side, the difference between pre and postoperative measures of the affected side, and the sensitivity to change, using Cohen’s $d$, for the three tests [3]. ‘Change’ refers to the difference between the mean pre and postoperative value. The formula for Cohen’s $d$ is (mean preoperative – mean postoperative)/SD, with SD being the pooled SD of both sessions. A value of 0.2–0.3 is regarded as small, around 0.5 as medium and >0.8 as large.

Reliability of the three tests was assessed with the intra-class correlation coefficient (ICC) between the pre and postoperative measures of the non-affected side. ICC values >0.70 were considered as acceptable and values >0.80 as accurate.

The correlations between the D-ATT, R-ATT, and M-ATT were calculated using pre and postoperative measures of both ankles of the three tests.

Table 1 Pre and postoperative measures of D-, R-, and M-ATT of both ankles with statistical significance of the difference between the affected and non-affected side and between preoperative and postoperative measures, Cohen’s $d$ for the affected side and intra-class correlation coefficient for the non-affected side

<table>
<thead>
<tr>
<th></th>
<th>Pre (SD)</th>
<th>Post (SD)</th>
<th>$P$ value*</th>
<th>Cohen’s $d$</th>
<th>ICC (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-ATT AS (mm)</td>
<td>9.6 (1.6)</td>
<td>9.7 (1.4)</td>
<td>0.833</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>D-ATT NAS (mm)</td>
<td>9.4 (1.4)</td>
<td>9.5 (1.5)</td>
<td>0.643</td>
<td>0.55 (0.28–0.74)</td>
<td></td>
</tr>
<tr>
<td>$P$ value*</td>
<td>0.464</td>
<td>0.189</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-ATT AS (mm)</td>
<td>4.6 (1.5)</td>
<td>4.1 (1.9)</td>
<td>$0.045$</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>R-ATT NAS (mm)</td>
<td>3.1 (1.7)</td>
<td>3.0 (2.1)</td>
<td>0.906</td>
<td>0.71 (0.51–0.84)</td>
<td></td>
</tr>
<tr>
<td>$P$ value*</td>
<td>&lt;0.001</td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-ATT AS (cat)</td>
<td>1.2 (0.4)</td>
<td>0.7 (0.5)</td>
<td>$&lt;0.001$</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td>M-ATT NAS (cat)</td>
<td>0.7 (0.7)</td>
<td>0.7 (0.5)</td>
<td>0.317</td>
<td>0.94 (0.88–0.97)</td>
<td></td>
</tr>
<tr>
<td>$P$ value*</td>
<td>&lt;0.001</td>
<td>0.593</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SPSS 15.0 for Windows was used for statistical analysis because of skewed distributions of most data, and the M-ATT being a test with categorical outcome, non-parametric tests were used to assess statistical significance of differences between means (Wilcoxon signed ranks test) and correlations (Spearman’s correlation test). $P$ values <0.05 were considered as statistically significant.

Results

The difference between postoperative measures of the affected side was statistically significant for the R-ATT and M-ATT but not for the D-ATT (Table 1; Fig. 1), Cohen’s $d$ was small for D-ATT and R-ATT and large for M-ATT (Table 1).

There was no statistically significant difference between pre and postoperative values of the D-ATT, R-ATT, and M-ATT for the non-affected side (Table 1). Intra-class correlations between pre and postoperative measures for the unaffected side were all statistically significant, with 0.55 for the D-ATT, 0.71 for the R-ATT, and 0.94 for the M-ATT (Table 1). A scatter plot of the pre versus postoperative measures of the D-ATT of the non-affected side shows that there is no strong linear correlation (Fig. 2). There were no correlations between the D-ATT, R-ATT, and M-ATT as well (Table 2).

Discussion

The most important finding of this study was that, in a clinical setting, the dynamic anterior ankle tester, designed
to measure anterolateral ankle ligament laxity, proved not
to be as reliable as suggested by earlier studies [16, 17].
‘Dynamic’ refers to the speed of the test that precludes
reflex muscle contractions that might interfere with the
measurement as seen in other (instrumented) tests [16].

The study was conducted to clinically evaluate the
dynamic anterior ankle tester (DAAT), concerning the
detection of increased ligament laxity, its reliability and to
compare the DAAT with radiographic and manual stress
testing of the ankle. In a group of 39 patients operated for
chronic lateral ankle instability, pre and postoperative
measures of anterior talar translation were taken with the
DAAT, ankle stress radiographs, and the manual anterior
drawer test.

The DAAT did not show increased laxity preoperatively
or a reduction in ligament laxity of the affected and
operated ankle postoperatively, whereas both the radio-
graphic and the manual test did show a statistically sig-
nificant increased laxity preoperatively compared to the
contralateral side and a statistically significant improve-
ment postoperatively compared to preoperatively. Addi-
tionally, the sensitivity to change of the DAAT was low
compared to the both other tests. The DAAT also had a low
reliability, whereas the radiographic and manual tests had
an acceptable and accurate reliability, respectively. No
correlations between the three tests were found.

The reliability of the DAAT was lower compared to
earlier studies with the same device [16, 17]. The current
study confirmed that there is no correlation between the
DAAT and radiographic or manual stress testing, as was
found earlier [17]. The difference in reliability between
the current (ICC 0.55) and the previous study (ICC 0.81–0.93)
is probably explained by the different group sizes and the
difference in range of the values used for reliability anal-
ysis. With the smaller group size used in the previous
study, the better reliability was potentially found by
change. The smaller range in ligament laxity in this study

Fig. 1 Statistical significance of the difference between pre
and postoperative measures for the affected side according to
the D-ATT, R-ATT, and M-

![Graph showing statistical significance](image)

Fig. 2 Scatter plot of pre and postoperative results of the D-ATT of
the non-affected side. Subscript: D-ATT DAAT anterior talar translation, Pre preoperative, Post postoperative

![Scatter plot](image)

Table 2 Correlations between the D-ATT, R-ATT, and M-ATT

<table>
<thead>
<tr>
<th></th>
<th>D-ATT</th>
<th>R-ATT</th>
<th>M-ATT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R (P value)*</td>
<td>R (P value)*</td>
</tr>
<tr>
<td>D-ATT</td>
<td>0.19</td>
<td>0.02</td>
<td>0.18</td>
</tr>
<tr>
<td>R-ATT</td>
<td>NA</td>
<td>0.24</td>
<td>0.03</td>
</tr>
</tbody>
</table>

D-ATT DAAT anterior talar translation, R-ATT radiographic anterior talar translation, M-ATT manual anterior talar translation, * Spearman correlation coefficient, NA not applicable

Table 2 Correlations between the D-ATT, R-ATT, and M-ATT

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D-ATT DAAT anterior talar translation, R-ATT radiographic anterior talar translation, M-ATT manual anterior talar translation, * Spearman correlation coefficient, NA not applicable
A limitation of the current study is that only one observer took the outcome measures. Whereas the DAAT, due to its design, is probably not very sensitive to application by different investigators, the radiographic test and especially the more subjective manual test are more dependent on how the test is performed. The clinical relevance of the current study is that it shows that lateral ankle ligament laxity, although an important clinical sign that may determine whether a patient will be operated on or not, remains difficult to quantitate objectively.

Conclusions

In contrast to earlier laboratory evaluation in a smaller group, the dynamic anterior ankle tester showed a low reliability in testing ankle ligament laxity in a clinical setting. The outcome warrants re-evaluation of the test device and its application.

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References