Diagnosis of ligament rupture of the ankle joint

Physical examination, arthrography, stress radiography and sonography compared in 160 patients after inversion trauma

C Niek van Dijk[1], Ben Willem J Mol[2], Liesbeth S L Lim[1], René K Marti[1] and Patrick M M Bossuyt[2]

We prospectively enrolled 160 consecutive patients with inversion trauma of the ankle in a diagnostic protocol that included physical examination within 2 days and at 5 days after trauma, arthrography, stress radiography, and ultrasonography. 135 patients had pathological lateral ligament laxity on the later physical examination or lateral ligament rupture diagnosed on arthrography and they were operated on. 122 of these patients had ligament ruptures.

At clinical follow-up after a minimum of half a year, all of the patients who were not operated on had stable joints without signs of previous ligament ruptures.

Delayed physical examination at 5 days after the injury led to the highest overall sensitivity (96%) and specificity (84%) for the detection of a ligament rupture. Additional diagnostic procedures, at a considerable cost, yielded little additional information.

Departments of [1]Orthopedics and [2]Clinical Epidemiology and Biostatistics, Academic Medical Centre, PO Box 22700, 1100 BE Amsterdam, The Netherlands. Tel +31 20 566-2672. Fax -4440
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Because of the suspected poor reliability of physical diagnosis of ligament ruptures after inversion trauma of the ankle, stress radiography, arthrography and sonography are often performed simultaneously (Kannus 1991). However, these methods are expensive and their reliability is also debated.

We tried to enhance the reliability of physical diagnosis. Our hypothesis was that the physical examination should be done several days after injury because of the diminished pain and swelling.

Patients and methods

We studied all 160 consecutive patients between 18 and 40 years of age who presented at our Accident and Emergency Department between March 1988 and January 1990 within 2 days after acute inversion injury of the ankle. Patients with a previous ankle injury or with fractures were not included. 116 were men and the right ankle was effected in 36 patients.

On admission, patients had a physical examination followed by arthrography. 5 days later, a new physical examination was followed by stress radiography and sonography. Surgery was performed on patients with a positive physical examination at day 5 and/or a positive arthrogram.

Physical examination within 48 hours after trauma

Swelling (> 4cm), formation of hematoma, localization of pain at palpation and the anterior drawer test (Figures 1 and 2) were assessed and the examiner recorded his diagnosis regarding lateral ligament rupture as positive/negative/inconclusive.

Delayed physical examination

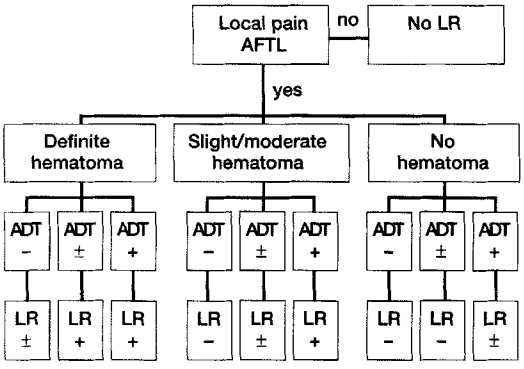
5 days later, all patients were examined again by an experienced orthopedic surgeon. Without knowing the result of this examination, 1 in a group of 4 inexperienced but well-instructed interns investigated the patient independently. The diagnosis was based on formation of hematoma, location of pain on palpation and the result of the anterior drawer test (Figures 1 and 2).

Additional diagnostic procedures

Within 48 hours after trauma, an arthrogram was made in all cases. The outcome was disclosed neither to the patient nor to the investigators until after the second delayed physical examination. Stress radiography was performed 5 days after trauma (n 153) using the Sheuba device (Telos GA-II/E) and was focused on talar tilt and drawer test (Lindstrand and Mortensson 1977).

Stress radiograms were considered to be positive when talar tilt exceeded 10° or the talar tilt left-right

Figure 1. Assessment of the painful ankle 4–7 days after inversion trauma.



ATFL anterior talofibular ligament,
ADT anterior drawer test,
LR ligament rupture.

difference was greater than 5°, and/or when we noted an anterior drawer of more than 4 mm or a left-right difference existed of more then 2 millimeters.

Ultrasonography was done in 74 consecutive cases.

Surgery

Patients suspected of a lateral ligament rupture at the delayed physical examination and patients with a positive arthrogram were operated on (n 135). All 3 lateral ankle ligaments—anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL) and posterior talofibular ligament (PTFL)—were inspected, as well as the anterior tibiofibular ligament. If a rupture was present, it was sutured end-to-end. After-care consisted of plaster immobilization for 5 days, followed by functional treatment. All 160 patients were followed for at least 6 months.

Measurement of effectiveness

The accuracy of the independent diagnostic procedures was expressed in terms of sensitivity and specificity of the strategy as a whole. Sensitivity of a test was defined as the proportion of patients with a rupture of the ATFL who were correctly identified by that test. Specificity of a test was defined as the proportion of patients without a rupture of the ATFL who were correctly identified by that test.

In all patients operated on, the intraoperative findings provided the definitive diagnosis. In the non-operatively treated group (negative arthrogram and negative physical examination), the definitive diagnosis was the clinical diagnosis at follow-up.

Decision analysis

The diagnostic methods described earlier were combined to form 13 diagnostic strategies. In a decision analytic framework, the overall sensitivity and specificity of each strategy were calculated (Table 1).

A prevalence rate of 70% was adopted. The initial analysis was done assuming the mutual conditional independence of all diagnostic procedures. This means that a positive result of one procedure, given either the presence or absence of a lesion, is neither more nor less likely after a positive result obtained previously with another test. This assumption was

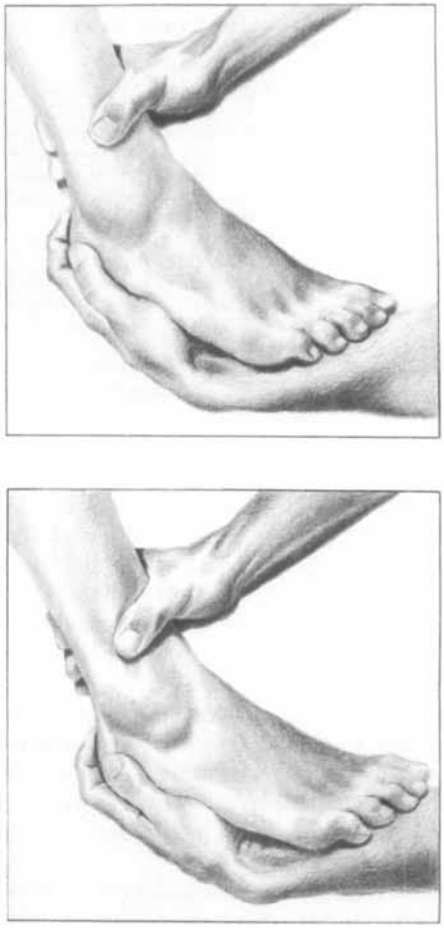


Figure 2. Anterior drawer test right ankle: the patients lies supine, the upper leg is supported by the couch, the knee joint is flexed, the ankle joint is held in 10–15° plantarflexion. The examiner's left hand grasps the heel, while the patient's foot lies on the anterior aspect of the examiner's lower arm. The examiner's right hand holds back the tibia.

Before the anterior drawer test is performed, the patient has to relax his muscles. The heel is then very gently pressed forward. When a rupture of the AFTL is present, the talus (and with it the foot) rotates out of the ankle mortis anteriorly. The center of rotation is the intact deltoid ligament. The forward movement of the talus results in a negative pressure which sometimes draws the skin inwards at the side of the ligament rupture: 'a dimple sign' (Jaffer Aradi 1988).

Table 1. The 13 main diagnostic strategies with their sensitivity, specificity and cost

Strategy		Sens %	Spec %	Cost USD
1.1	Physical examination (PE) < 48 hours	71	33	23
1.2	PE + when inconclusive; arthrography	82	33	36
1.3	PE + when inconclusive; stress radiographs	79	33	30
1.4	PE + when inconclusive; ultrasound	81	33	34
2.1	Arthrography	96	71	141
2.2	Stress radiographs	68	71	78
2.3	Ultrasound	92	64	111
3.1	Delayed PE, experienced investigator	96	84	44
3.2	Delayed PE + when inconcl.; stress radiographs	99	75	56
3.3	Delayed PE + when inconcl.; ultrasound	100	72	55
4.1	Delayed PE by inexperienced investigator	89	70	40
4.2	Delayed PE + when inconcl.; stress radiographs	94	63	49
4.3	Delayed PE + when inconclusive; ultrasound	97	61	52

checked by recalculating all results, without assuming independence. If there were few, if any, effects on the results, the assumption of conditional assumption was taken to be tenable. In that case, the full data set could be used, leading to a decreased uncertainty about the sensitivity and specificity of the individual procedures.

The strategies were divided into 4 main groups:

1. Physical examination by an emergency physician within 48 hours after trauma, with or without arthrography, stress radiograms or ultrasound.

2. Each of the imaging techniques applied to all patients.

3. Delayed physical examination performed by an experienced orthopedic surgeon with or without stress radiograms or ultrasound.

4. Delayed physical examination performed by 1 of 4 inexperienced but well-instructed physicians with or without stress radiograms or ultrasound.

For each of the combined strategies (strategies 1, 3, and 4), 2 options were analyzed: either the imaging procedure was applied to patients in whom the physical examination was inconclusive or the imaging procedure was applied to patients in whom the result of physical examination was inconclusive or positive.

Costs

The cost of each alternative diagnostic strategy was defined as the cost of administering the diagnostic test (without considering the cost of treatment). It consisted of costs of staff, material, equipment, and accommodation, and was computed by interviewing coworkers who dealt with the primary process. The result was a mean value for each strategy.

Morbidity (suffering, disability) and non-medical costs (income loss, disability benefits paid) were not considered. In calculating the costs of the delayed physical examination strategy, it was assumed that each patient first went to an Accident and Emergency room and from there was sent to an orthopedic surgeon who performed the delayed physical examination. The price of all delayed physical examination strategies therefore included the costs of a visit to the Accident and Emergency room.

Sensitivity analysis

A comparison was made between the situation in which inconclusive judgments were regarded as negative and the situation in which they were regarded as positive.

Results

25 patients had a negative arthrogram and showed no clinical signs of an ankle ligament lesion at the delayed physical examination. These patients were not operated on. The follow-up at 6 months was uneventful in all these cases.

Of the remaining 135 patients, 6 had a positive delayed physical examination and a negative arthrogram, 12 cases had a negative delayed physical examination and a positive arthrogram, while 117 patients had both a positive delayed physical examination and a positive arthrogram. At surgery 122 patients had a ligament lesion which was multiple in 55 cases.

Analysis

13 different strategies were analyzed in terms of sensitivity, specificity and associated costs for the diagnosis of a lateral ankle ligament rupture (Table 1, Figure 3). Other strategies did not make clinical sense.

Physical examination within 48 hours (strategy 1.1) was cheap but not accurate. Delayed physical examination by an experienced investigator (strategy 3.1) led to the highest overall sensitivity and specificity, at

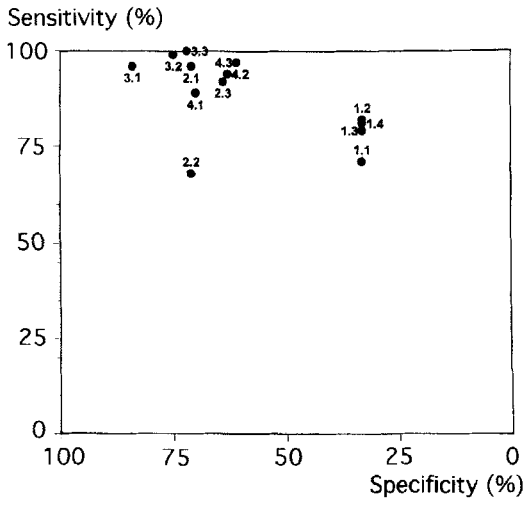


Figure 3. Sensitivity and specificity of the main strategies. For explanation of the tables, see Table 1.

a cost of USD 44. None of the additional diagnostic procedures improved the accuracy of this test strategy. These results were almost matched by strategy 4.1, delayed physical examination by the inexperienced but well-instructed investigator. All other strategies yielded no extra information but at a considerable cost.

Sensitivity analysis

Multiple sensitivity analysis was performed using the variables outlined in the Methods section. Plausible changes in the parameters did not alter the ranking of the procedures in this study. When inconclusive judgements were regarded as positive, results were inferior to the situation in which inconclusive judgments were regarded as negative.

Discussion

It has been estimated that one inversion injury of the ankle per 10,000 people occurs each day (Stiell et al. 1994). Soboroff et al. (1984) reported that the cost of evaluation and treatment of ankle injuries in the US amounts to approximately 2 billion dollars a year. Therefore an evaluation of the diagnostic policy after an inversion trauma of the ankle is important for medical and economic reasons.

The current therapeutic standard for ligament rupture of the ankle is taping, which is relatively cheap and not onerous. We therefore wanted to find a test with a high sensitivity, whereas specificity is of less importance.

We compared 13 diagnostic strategies concerning effectiveness (sensitivity and specificity) and costs. Physical examination by an Accident and Emergency physician within 48 hours of trauma proved to be unreliable, having a sensitivity of 71% and a specificity of 33%. This is comparable to earlier observations (Broström 1965, Percy et al. 1969, Sanders 1972, Volkov et al. 1973, Reichfeld 1976, Hutton 1985, Lindstrand and Mortensson 1977). We found a great improvement in sensitivity and specificity when the physical examination was delayed until 5 days after trauma. One explanation of this improvement is that pain at palpation is better localized to the site of ligamentous injury. Furthermore, in the acute situation it is impossible to distinguish between edema or hematoma as the cause of the swelling. If a hematoma is present, the skin discoloration appears only some days after the trauma. Presence of hematoma discoloration and pain on palpation at the ATFL has a sensitivity of 90%. Stability tests will also be much better tolerated by the patient, due to the diminished pain. The combination of pain on palpation at the ATFL, presence of hematoma discoloration and a positive anterior drawer test has a sensitivity of 96% (Figure 1).

Considering costs, the delayed physical examination is preferable to all other strategies.

Strategies which provide a diagnosis within 48 hours of trauma (physical examination by an Accident and Emergency physician, arthrography, stress radiographs and ultrasound) are, from the viewpoint of effectiveness, inferior to delayed physical examination. Only arthrography is comparable to the delayed physical examination.

In our study, a fracture seen on radiograms was an exclusion criterion. However, recent literature has shown that it is cost-effective to rely on physical examination in the diagnosis of an ankle fracture (Stiell et al. 1994). In view of the results of our study we suggest a protocol for a patient who visits the first aid department with a painful acute ankle injury. Physical diagnosis according to the "Ottawa Ankle Rules" is first made to rule out a fracture (Stiell et al. 1994). Patients without a fracture are then advised to elevate their leg and limit their walking. A compressive or elastic bandage can be applied. A new physical examination takes place 4–5 days later, to rule out a ligament lesion.

A delay in the diagnosis of ligament rupture and therefore a delay in definite treatment causes no delay in the healing process because the current treatment of choice—functional tape treatment—can be started only when the swelling has subsided. If applied sooner, there is a risk of pinching off or loosening of the tape.

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