Diagnosis of lateral ankle ligament injuries

Comparison between talar tilt, MRI and operative findings in 112 athletes

Christian Gaebler[1], Christian Kukla[1], Martin J Breitenseher[2], Zack J Nellas[3], Martina Mittlboeck[4], Siegfried Trattnig[2] and Vilmos Vécsei[1]

We evaluated the reliability of the radiographic talar tilt test by MRI examinations in 112 athletes with injuries to the lateral ligaments of the ankle. 25 athletes with a talar tilt > 15° were treated operatively. Intraoperative findings and the talar tilt test were compared with MR imaging results. Our results suggest that MRI is a reliable method for diagnosing injuries of the lateral ankle ligaments. The talar tilt test cannot evaluate the specific pathology of lateral ankle ligaments, but it was reliable in indicating complete double-ligament ruptures (anterior talofibular and calcaneo-fibular ligaments), when talar tilt was 15° or more than on the uninjured side.

[1]University of Vienna, Clinic for Trauma Surgery, AKH-Währinger Gürtel 18–20, 1090 Vienna, Austria. Tel +43 1 40400-5619. Fax -5939, [2]University of Vienna, MRI and Osteology Unit of the Department of Radiology, [3]Dept. of Podiatric Surgery, St. John Hospital Macomb Center, Harrison twsp., Michigan, USA [4]University of Vienna, Department of Medical Computer Sciences
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The inversion stress test is commonly used to evaluate injuries of the lateral ligaments of the ankle joint. However, there is no standardized value for the degree of talar tilt, which indicates instability. Some authors postulate that a talar tilt of more than 5° compared to the unaffected side indicates a significant injury of at least one of the lateral ligaments (Broström 1965, Smith and Reischl 1986, Boruta et al. 1990). Other authors state that a talar tilt of 15°–30° greater than the uninjured side indicates only moderate instability (Rubin and Witten 1960, Laurin et al. 1968, Verhaven et al. 1991, Marder 1994, Verhagen et al. 1995). At our clinic, reconstruction of the lateral ligaments is performed only in suspected triple-ligament lesions and we have used a talar tilt 15° greater than the uninvolved side, as an indication for operative treatment. However, intraoperatively we have often found double- and occasionally single-ligament injuries. If we had been able to determine preoperatively which ankle ligaments were ruptured, we would have treated single- or double-ligament injuries operatively.

We determined the correlation of the talar tilt test to the grade of injury and the possibility of evaluating instabilities in lateral ankle ligament injuries by MR imaging.

Patients and methods

From 1994 to 1996, 112 patients (67 men) with inversion trauma to the ankle and typical clinical symptoms of a ligament injury were examined. Only professional and amateur athletes, without previous ankle injuries or instability problems, were included in the study. The average age was 26 (16–35) years. Ball sports were responsible for half of the injuries. The average time to presentation was 0.7 (0–5) days after trauma.

After exclusion of fractures by conventional anteroposterior and lateral radiographs, stress radiography was performed under local anesthesia (intraarticular instillation of 5 mL mepivacaine 2%) to avoid peroneal muscle tension caused by pain. The foot was subjected to an inversion stress by a leather loop and by the application of a 3 kg weight (Beck and Frick 1979, Wruhs et al. 1985). The angle created by a line drawn parallel to the tibial plafond and the superior surface of the talus showed the degree of talar tilt (Boruta et al. 1990, Marder 1994). The talar tilt angles in the unaffected and in the injured ankle joints were compared, to exclude cases of idiopathic ligamentous laxity. The patients were classified in 3 groups: I talar tilt < 5° compared to the uninjured side, II talar tilt 5–15° compared to the unaffected side, group III talar tilt > 15°. All 25 patients in group III were operated on by 5 senior residents, who described the extent of

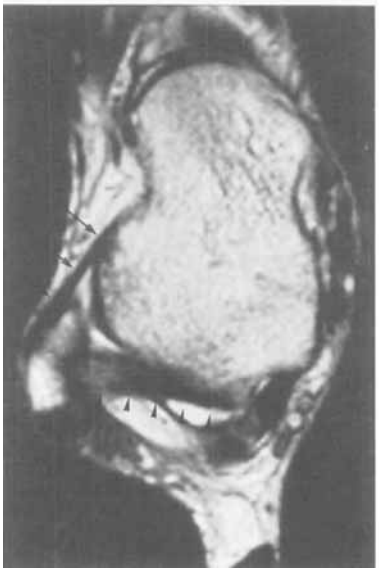

Figure 1. Grade 0 ankle sprain in a 31-year-old woman. The axial T2-weighted MR image with the foot in 10°–20° of dorsiflexion shows an intact anterior talofibular ligament (arrows) and an intact posterior talofibular ligament (arrow-heads).

Figure 2. Grade II cc injury in a 24-year-old man. The axial T2-weighted MR image with the foot in dorsiflexion demonstrates a complete rupture (discontinuity) of the anterior talofibular ligament (arrow-heads). Hemarthrosis presents as an area of high signal intensity (arrows).

injury to the lateral ankle ligaments and joint structures, without knowing the results of the MRI scans. The 3 lateral ankle ligaments were examined intraoperatively and described individually.

MRI examination

Within a mean of 3 (0–5) days after the injury, 0.5 and 1.0 Tesla MR imaging (Gyroscan, Philips, Eindhoven, Netherlands) with axial T1-weighted SE (spin-echo) sequences (3-mm section thickness, 10% intersection gap) and T2-weighted TSE (turbo-spin-echo) sequences (4-mm section thickness; 10% intersection gap) was performed with the foot—fixed to a thermoplastic splint—in dorsiflexion (20°) to evaluate the anterior and posterior talofibular ligaments. In plantarflexion (45°), axial images were obtained for visualization of the calcaneofibular ligament (Schneck et al. 1992, Breitenseher et al. 1996). To reveal bone injuries, coronal STIR (short tau-inversion recovery = T2-weighted with fat suppression) sequences (3 mm section thickness, 10% intersection gap) were obtained with the foot in dorsiflexion. The assessment of the MRI scans (Figure 1) was performed by a senior radiologist, who was blinded to the findings of radiography. The diagnosis of complete ligament ruptures (Figures 2 and 3) was made by the demonstration of discontinuity and ligamentous stumps. Incomplete ruptures of ligaments and elongation injuries (microruptures of filaments) were diagnosed when irregular thickening of the ligament (Figure 4), wavy contours and an increased signal intensity (T2-weighted sequences) in the ligament (intraligamentous edema) were seen. A bone bruise (Figure 5), defined as a possible occult fracture, characterized by hemorrhage, edema, hyperemia and microscopic compression fractures of trabecular bone, was

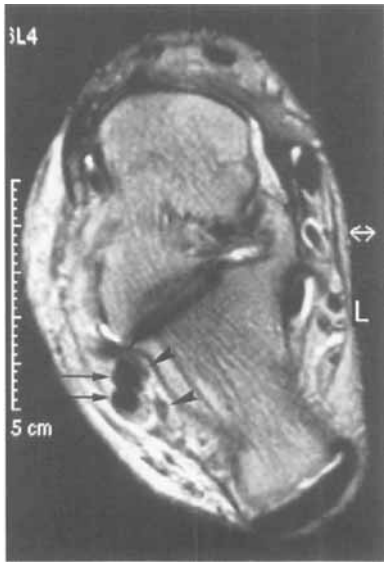

Figure 3. Grade III cci injury in a 23-year-old man. The T2-weighted axial MR image with the foot in 45° plantarflexion reveals a complete rupture (discontinuity) of the calcaneofibular ligament (arrow-heads). The peroneal tendons (arrows) are intact.

Figure 4. Grade II ii injury in a 31-year-old man. The T2-weigthted axial MR image with the foot in dorsiflexion demonstrates an incomplete rupture (irregular thickening, increased signal intensity and wavy contours) of the anterior talofibular ligament (arrow-heads) and hemarthrosis (arrows).

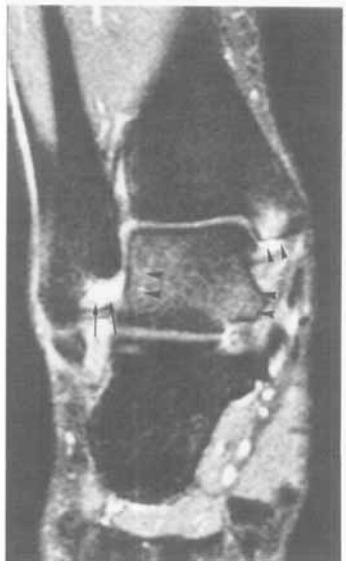

Figure 5. Grade III ccc injury in a 21-year-old woman. This coronal STIR sequence with the foot in dorsiflexion shows a bone bruise (area of increased signal intensity) of the talus (large arrow-heads), a bone bruise of the medial malleolus (smaller arrow-heads) and hemarthrosis (arrows).

seen as areas of high-signal intensity on STIR and T2-weighted images and of low-signal intensity on T1-weighted images (Yao and Lee 1988, Mink and Deutsch 1989, Liou and Totty 1991, Kaplan et al. 1992, Schneck et al. 1992, Mesgarzadeh et al. 1994).

On the basis of our MRI findings, we developed a classification for ligament injuries: grade 0 is ankle sprains without ligament lesions, grade I is lesions of the anterior talofibular ligament, grade II is lesions of the anterior talofibular ligament and of the calcaneofibular ligament and grade III is triple-ligament injuries. The lesions are further subdivided into incomplete ruptures (i) and complete ruptures (c). For example, a III cii injury indicates a triple-ligament injury with a complete rupture of the anterior talofibular ligament and an incomplete rupture of the calcaneofibular and of the posterior talofibular ligaments.

Statistics

The sensitivity and specificity of the MRI assessment related to the operative findings were calculated with the 95% confidence interval (CI). The MRI of the first 56 patients were classified into the 4 MRI groups independently by 2 radiologists (a senior and a resident radiologist). The senior radiologist performed a second evaluation of these MRI scans 1 month after the initial evaluation. Inter- and intra-observer reliability were calculated in terms of the kappa statistics. Agreement was defined as almost perfect when kappa was 0.81–1, good when kappa was 0.8 –0.61, moderate when kappa was 0.6–0.41, fair when kappa was 0.4–0.21 and poor when kappa was < 0.20

Results (Tables 1 and 2)

The mean talar tilt of group I (24 patients) was 0.8° (0°–4°). MRI showed 12 cases without ligament injury, lesions of the anterior talofibular ligament in 7 cases and double-ligament injuries in 5 cases. Hemarthrosis was found in 20 patients. A bone bruise of the talus was found in 11 patients and of the medial malleolus in 3 cases.

The mean talar tilt of group II (63 patients) was 10° (5°–15°). MRI demonstrated triple-ligament injuries in 21 patients. The posterior talofibular ligament showed an incomplete rupture in all of these cases. MR revealed a double-ligament injury in 25 patients and single-ligament involvement in 16 patients. There was only 1 grade 0 injury. MR imaging also showed hemarthrosis in 60 patients. A bone bruise of the talus was found in 30 patients. In 1 case, an osteochondral talar dome lesion was found with a III cci injury; the talar tilt was 13° compared to the uninjured side. A bone bruise of the medial malleolus was found in 9 cases.

The mean talar tilt of group III (25 patients) was 22° (16°–45°). All these patients underwent primary

Table 1. Grade of ankle ligament injury by MRI in relation to side-difference in talar tilt

		MR grades									
		0	I		II				III		
	n		i	c	ii	ic	ci	cc	cii	cci	ccc
Talar tilt < 5°	24	12	1	6	–	1	3	1	–	–	–
5–15°	63	1	2	14	3	–	7	15	12	9	–
> 15°	25	–	–	–	–	–	–	9	–	14	2

grade 0 all ligaments intact
grade I lesions of the anterior talofibular ligament
grade II lesions of the anterior talofibular ligament and of the calcaneofibular ligament
grade III triple-ligament injuries
i incomplete rupture, c complete rupture

suture of injured ligaments (Table 2). A complete rupture of the anterior talofibular ligament was found intraoperatively in all cases and MR imaging had described the lesion correctly; thus the sensitivity was 100% (95% CI 89–100). In all 25 cases, intraoperative findings showed a complete rupture of the calcaneofibular ligament. In 22 cases, MR imaging had shown the lesion correctly, but in 3 cases, an intact calcaneofibular ligament had been visualized with MRI. Sensitivity was 88% (95% CI 69–98). Intraoperative findings revealed 2 complete ruptures of the posterior talofibular ligament (also seen with MRI) and 9 partial ruptures or elongation injuries. MRI showed 14 partial ruptures or elongation injuries of the posterior talofibular ligament (these were the 9 partial ruptures described intraoperatively and another 5 cases of intraligamentous edema). Sensitivity of MRI scans in the diagnosis of posterior talofibular ligament rupture was 100% (95% CI 76–100). Specificity was 64% (95% CI 35–87).

Table 2. Clinical data, talar tilt, MRI and operative findings in the 25 patients of group III (talar tilt > 15°)

Age	Sex	TTU	TTI	Diff.	MRI	OP	Talus	MM
21	f	0	16	16	II ii	II ii	0	0
22	m	3	20	17	II ii	II ii	1	0
35	f	0	18	18	III iic	II ii	1	0
32	m	8	26	18	II ii	II ii	0	0
35	f	3	21	18	II ii	II ii	1	0
25	f	4	22	18	III iic	III iic	0	0
29	f	6	25	19	II ii	II ii	1	0
23	m	2	22	20	II ii	II ii	0	0
27	m	0	20	20	II ii	II ii	1	0
35	m	3	23	20	III iic	III iic	1	0
21	m	2	22	20	III iic	III iic	0	0
29	m	0	20	20	III iic	II ii	0	0
20	f	2	22	20	III iic	II ii	0	0
29	m	4	25	21	II ii	II ii	1	0
19	f	4	25	21	III iic	III iic	0	0
32	f	0	22	22	III iic	III iic	0	0
25	m	0	22	22	III iic	III iic	1	0
19	m	2	24	22	III iic	II ii	1	0
27	m	0	24	24	III iic	III iic	1	0
29	f	4	28	24	III iic	III iic	1	0
20	f	0	25	25	III iic	II ii	1	1
24	m	2	28	26	II ii	II ii	0	0
32	m	0	30	30	II iii	III iii	1	0
34	m	0	34	34	III iic	III iic	1	0
21	f	5	50	45	III iii	III iii	1	1

TTU talar tilt of uninjured side (degrees), TTI talar tilt of injured side (degrees), Diff. talar tilt side-difference, MRI grading of MRI findings, symbols as in Table 1, OP grading of intraoperative findings, symbols as in Table 1, Talus 0 normal, 1 bone bruise of talus, MM 0 normal, 1 bone bruise of medial malleolus

MRI imaging showed hemarthrosis in all patients in group III. A bone bruise of the talus was seen in 15 patients, a bone bruise of the medial malleolus in 2 patients. Comparing the talar tilt test to the operative findings and MRI results, we determined that the probability of suffering a triple-ligament injury to the lateral ankle ligaments was 0.6 in patients with a talar tilt of more than 20°. Only a talar tilt 30° greater than on the uninjured side indicated a triple-ligament injury with a 1.0 probability.

Interobserver reliability of MRI assessment (n 56) demonstrated fair agreement (kappa 0.40), intraobserver reliability demonstrated good agreement (kappa 0.65). The highest agreement was achieved in the assessment of the anterior talofibular ligament, followed by the calcaneofibular ligament and the posterior talofibular ligament. Comparing the MRI results of the senior and the resident radiologist with the operative findings, the resident had a higher ($p < 0.001$) rate of wrong results.

Discussion

To exclude cases of idiopathic ligamentous laxity, we examined the talar tilt of both the injured and the uninjured side. Our findings suggest, however, that this may be unnecessary. The correlation between the dif-

ferences in talar tilt (i.e., injured to uninjured side) side and the corresponding MRI grade of injury was only slightly better than that of the injured side alone. Careful clinical examination of the uninjured side should be performed to exclude ligamentous laxity, which could mimick a pathologic talar tilt of the injured side. However, we did not find a substantial ligamentous laxity in any of our cases.

Our observations indicate that the talar tilt test is not always reliable in evaluating the exact extent of lateral ankle ligament injuries. However, it was obvious that a talar tilt of 15° or more, compared to the uninjured side, always indicated a complete rupture of the anterior talofibular and calcaneofibular ligaments. The high rate of bone bruise injuries to the talus is probably explained by the pathomechanism of the inversion injury, where the medial malleolus is wedged against the talus. This mechanism also induces shear forces that may cause osteochondral lesions of the talar dome.

Our findings suggest that MRI is a useful method for evaluating instabilities in lateral ankle ligament injuries, which is in accordance with previous studies (Beltran et al. 1990, Ferkel et al 1991, Liou and Totty 1991, Marder 1994, Breitenseher et al. 1996). The injuries can be diagnosed up to several days after trauma so that painful stress radiographs and injuries of the organizing granulation tissue of older ankle sprains are avoided. MR images can visualize intraligamentous lesions, which may not be visible intraoperatively. This is shown by the fact that intraoperatively only 9 cases of partial ruptures of the posterior talofibular ligament were found, while MRI visualized an additional 5 cases of intraligamentous edema. The low interobserver reliability, compared to the high intraobserver reliability, demonstrates the importance of cooperating with experienced radiologists.

We do not recommend MRI examinations of every patient with an ankle sprain. Our findings suggest that talar tilt between 5° and 20° in professional athletes, who depend on quick recovery, should be an indication for MR imaging to exclude triple ligament injuries. A secondary indication for MRI is patients presenting with several day-old ankle sprains and massive clinical symptoms to avoid the talar tilt test.

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