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ASSESSMENT OF INJURY EXTENSIVENESS AT ANKLE DISTORTION BY MAGNETIC RESONANCE IMAGING

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SUMMARY – The aim of the study was to evaluate the status of all soft tissue and osseous structures by magnetic resonance imaging (MRI) in patients with acute ankle injury. During a two-year period (2001-2003), 50 patients with acute ankle injury (osseous injury excluded by conventional radiography) underwent MRI evaluation within 7 days of injury infliction. The following injuries were confirmed: joint effusion, joint capsule extension, lateral collateral ligament injury, fibular malleolus infraction, flexor hallucis longus tendon injury, brevis and longus peroneus tendon injury, infraction of talus, and injury of tibiofibular syndesmosis. Study results pointed to a great variety of capsule-ligament and osseous structure injuries as well as to the existence of injuries undetectable by clinical examination and conventional radiography, where MRI proved highly useful in identifying selected patients sustaining ankle injury.

Key words: *Ankle, injury – diagnosis; Magnetic resonance imaging; Ankle injuries – surgery*

Introduction

The ankle is the most loaded joint in the human locomotor system, and it consists of a distal tibiofibular joint, tibiotalar joint and talofibular joint. The joint stability is provided by congruent joint units (tibia and fibula, which cover talus with their malleoli) and capsuloligamentous structures, i.e. the joint capsule, tibiofibular connections (interosseous membrane, anterior and posterior syndesmosis), lateral collateral ligament (which consists of anterior and posterior talofibular and calcaneofibular ligament), and medial collateral ligament (two-branch deltoid ligament, which consists of a deep and surface layer)[1]. In a close anatomic relation with osseous-ligamentous structures of the upper leg joint there are also the following tendons: Achilles tendon in the back in the medial line; tendons of the short and long peroneal muscles laterally in the back behind the fibula; tendons of the posterior tibial muscle and long flexor muscle of great toe medially in the back; tendon of the anterior tibial muscle in the front in the medial line; and laterally from it tendons of the long extensor muscle of great toe and long extensor muscle of toes[2].

The biomechanics of the upper leg joint derives from the cylindric shape of the malleolar bone, which is in the front wider and slightly spirally bent. The upper leg joint together with the lower leg joint, Chopart's and Lisfranc's joints provides foot mobility in all directions. The most important stabilizing element in the upper leg joint is the lateral collateral ligament[3].

From the pathoanatomical point of view, distortion (Lat. *distorsio*, breaking away through inversion), the most frequent injury of the ankle, represents strain and/or partial tear of the stabilizing connective structures with preserved congruency of the joint osseous sections[1,3] (Table 1).

Distortion usually occurs in the form of a typical mechanism, forced adduction along with foot inversion, where

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Table 1. Injuries of the ankle

1) Distortion: 3 degrees are distinguished according to the pathoanatomic substrate and clinical scope of ankle injury: degree I – distention (strain): the load has not exceeded the limit of the ligament firmness or joint capsule, however, it has caused a microtrauma of the fibers with transitory circulation disorder; degree II – incomplete rupture (sprain, excessive strain): cracking or partial interruption of the ligament or joint capsule continuity, which occurs because the traumatizing force has exceeded the limit of firmness but not to an extent that would completely break its continuity, so some fibers are not affected; degree III – complete rupture of the ligament or joint capsule: it can be followed by tearing a small piece of cartilage, which can remain as a loose fragment within the joint.
2) Luxation
3) Fracture, which can be classified into: (a) luxation (b) compressive (c) other atypical fractures

injury to the lateral collateral ligaments (usually the anterior talofibular ligament and, in case of a more severe injury, the calcaneofibular ligament) is expected in approximately 98% of cases[1,4,5]. In case of injury to the ankle through the mechanism of eversion, injury of the medial collateral ligaments along with foot abduction may be expected, yet simultaneous fracture of the lateral malleolus is most common, therefore these injuries are not classified as distortion[1].

Also, simultaneous injuries to other soft tissue structures in the area may occur with ligament strain, e.g., Achilles tendon, tendon of the posterior tibial muscle, long and short peroneal tendons, tendons of the long flexor of great toe or flexor of toes, and less frequently of the anterior tibial muscle tendon and other tendons in the area, cartilage injuries, interosseous ligament, conventional radiography invisible osseous injuries of the malleoli and talus, and intra-articular fractures[1,3-5]. The mechanism of injury infliction depends on the forced flexion of the foot (dorsal or plantar), along with simultaneous adduction and inversion of the foot, so these injuries usually follow a lateral collateral ligament injury to a certain extent, thus proceeding unrecognized (on clinical examination).

On clinical presentation, we observed pain, reduced function of the ankle, edema, and hematoma in degree II and III injuries. In complete rupture of the ligament (degree III), instability of the joint was detected[1,3-5].

Clinical tests and diagnostic methods used to assess the extent of injury and possible joint instability include the following: stress test, inversion and eversion, and anteroposterior, to demonstrate difference between the abnormal and normal joint[1], and to raise clinical doubt about possible subluxation of the ankle; arthrography; conventional radiography as a standard examination to exclude osseous injury (malleoli, talus, calcaneus and metatarsal bones); magnetic resonance imaging (MRI), enabling full insight into extensiveness of the injury within all structures of the area[6-12]; and ultrasound (US)[13]. Late complications may develop as a consequence of inappropriate treatment, distortion and failure to recognize injury extensiveness[1,3,14-16] (Table 2).

Table 2. Late complications of ankle injury

1) Post-traumatic osteoarthritis – consequence of either cartilage injury or chronic instability
2) Scar of talofibular joint – consequence of the calcaneofibular ligament lesion, after which a tongue-shaped scar is formed between the talus and the fibula
3) Sinus tarsi – pain in tarsal sinus occurring months after ankle distortion consequential to scar formation in tarsal sinus
4) Exostosis on the talus and tibia – consenquence of forced foot dorsiflexion
5) Osteochondritis dissecans – intra-articular rupture of the talus caused by forced inversion along with severe dorsiflexion or plantar flexion

Treatment modality of an acute injury depends on the injury degree, and the main goal is recovery and complete function of the ankle, while avoiding chronic instability of the joint and other late complications[1,4,5,16-18,21].

Patients and Methods

Over a two-year period (2001-2003), 50 patients with acute distortion underwent MRI of the ankle within 7 days of injury infliction. There were 28 men and 22 women, all nonsportsmen, aged 24-65 (mean age 46.5) years. According to history data, 15 patients had sustained a similar injury earlier in life. All patients showed a characteristic mechanism of injury infliction, i.e. forced adduction along with foot inversion. Clinical examination revealed local

edema, pain on palpation in the area of lateral collateral ligaments, hematoma, and painful and reduced mobility of the ankle. There were no overt clinical signs of joint instability. After clinical examination all patients underwent conventional radiography, which excluded the existence of osseous injury. The the patients were referred for MRI of the ankle (Siemens Harmony, 1.0 T, Germany, with gradient and SE spirals). On MRI, the foot was fixed in neutral position, in soft plantar flexion. The imaging protocol involved T1 sequence (TR 640, Te 20; 6 min, 5 s), FSE T2 sequence (TR 4000, TE 96 ms; 5 min, 25 s), STIR sequence (TR 2858, TE 35, TI 135; 5 min, 1 s), Matrix (336x312, 4mm; 5 min, 25s) and FOV (200x200). All sequences were used in the same planes (axial, coronary, diagonal and transverse cross-sections), providing an insight into all structures of the leg joint area (bones, ligament cartilage, tendons and neurovascular structures)[6-14,19]. No paramagnetic contrast medium was used. Axial T1 images (high signal) provided the best insight into the existence of acute injuries of the lateral collateral ligament, short and long peroneal tendon, and other great toe and toe flexor tendons. MRI is the only method that can visualize osseous edema as a sign of acute lesion by STIR imaging (high signal at the site of osseous lesion). Images were evaluated by two radiologists cooperating with surgeon.

All patients received conservative treatment. The conservative treatment consisted of initial immobilization with a splint (until swelling disappeared), an early start with physical therapy and restrain from the injured leg load (walking with crutches) until pain ceased. In patients with confirmed tendon and ligament injuries immobilization lasted for 3 weeks (1 week of strict rest), and in those with osseous injury for 4 weeks. In patients in whom MRI demonstrated occult osseous injury control conventional radiography was carried out after several weeks, when the existence of osseous fracture was confirmed.

Results

MRI confirmed the following injuries in the ankle joint area: joint effusion, extension of joint capsule, injury of lateral collateral ligaments, occult infraction of fibular malleolus, injury of the long flexor great toe muscle tendon, injury of the short and long peroneal tendon, occult infraction of talus, and injury to posterior tibiofibular syndesmosis. Combined injuries were recorded in many patients (Table 3).

Table 3. MRI reconfirmed the following injuries associated with ankle distortion

Type of injury	Number of patients (N=50)
Joint effusion	50 (100%)
Extension of joint capsule	25 (50%)
Injury of long great toe flexor muscle tendon	9 (18%)
Injury of lateral collateral ligaments	24 (48%)
Injuries of long or short peroneal tendon	20 (40%)
Injury of posterior syndesmosis	4 (8%)
Infraction of talus	4 (8%)
Infraction of fibular malleolus	4 (8%)

The most common finding was joint effusion or hemarthrosis, observed in all patients, followed by peroneal muscle tendon injury (long or short) in 20 patients, and injuries to one of the lateral collateral ligaments in 24 patients (Fig. 1).

Injuries to peroneal muscle tendon and the long great toe flexor tendon were partial (incomplete). The peroneal tendon injuries were mainly followed by injuries to lateral

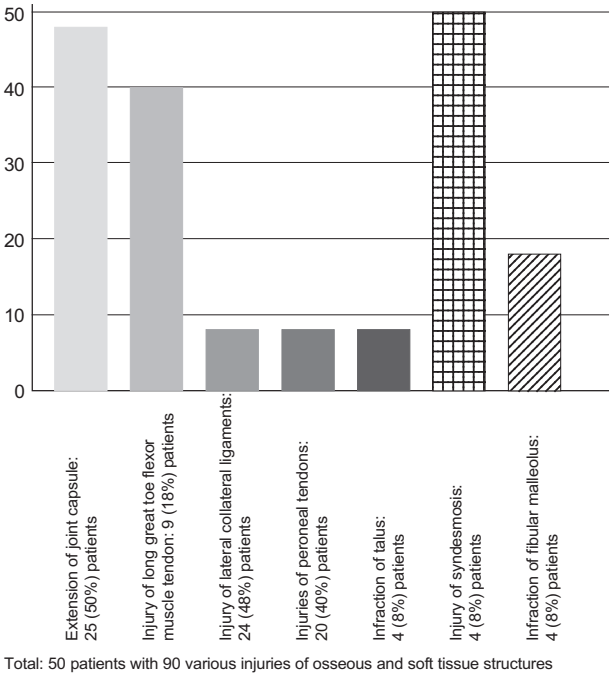

Fig. 1. Correlation of various injuries at ankle distortion

collateral ligaments in these patients. The existence of osseous injury was confirmed in all of the remaining eight patients, which was not recorded on either initial or control conventional radiography.

Discussion

Distortion of the ankle is a very common diagnosis in daily routine of emergency outpatient surgery[19]. On evaluation of these injuries, the absence of osseous injury usually has to be confirmed by clinical examination and conventional radiography. Other diagnostic methods that would enable appropriate injury evaluation (stress, arthrography, arthroscopy, US, MRI) generally have not been performed.

At distortion of the ankle through a typical mechanism of injury (forced adduction with foot inversion), lateral collateral ligament injury of a variable severity occurs in some 98% of cases[1,3,4,15,16]. Usually it is an injury to the anterior tibiofibular ligament (Fig. 2), and in more severe injury also of the calcaneofibular ligament, whereas injury to the posterior tibiofibular ligament is very rare and never occurs in isolated form[1].

The injury of the lateral collateral ligament itself can be diagnosed on the basis of clinical examination and mechanism of injury, along with conventional radiography to rule out malleolar fracture, which does not require MRI. However, injuries to lateral collateral ligaments are (very often) followed by injuries of the short and long peroneal muscle tendons (Fig. 3), tendon of the long flexor muscle of great toe, and interosseous ligament. Depending on the accompanying foot flexion, osseous injuries (sometimes intra-articular) cannot be visualized by conventional radiography[1,3,4,15,16,19,20]. A failure to recognize these injuries and inappropriate treatment of distortion in these cases may cause chronic instability of the joint and development of other late complications (post-traumatic arthritis, scar formation, tarsal sinus syndrome, exostosis, and osteochondritis dissecans)[1,14,20,22]. The occurrence of chronic discomforts in the ankle area is a consequence of failure to recognize the injury extent and its inappropriate treatment. Clinically unrecognized instability of the ankle may be a cause of longterm disturbance and chronic instability. A lateral shift of the talus by l mm leads to a reduction of the talus and tibia contact surface by 42%, which significantly increases the

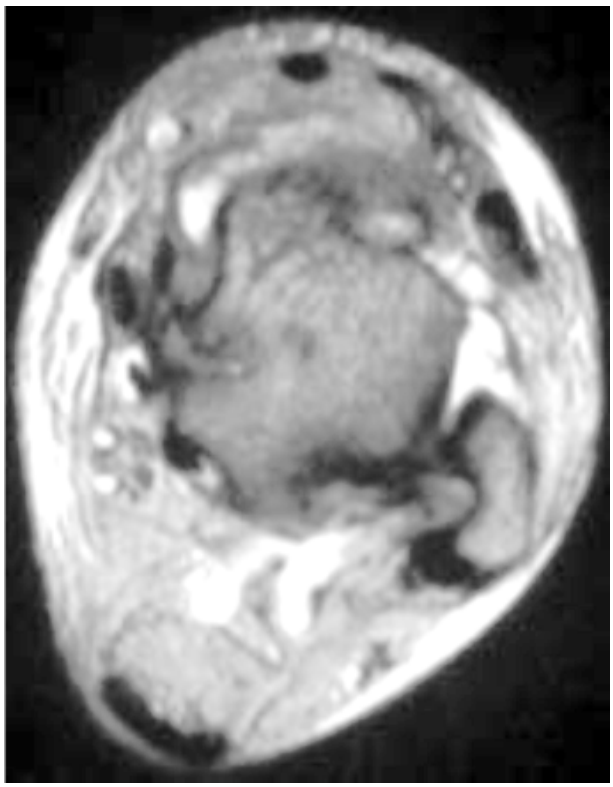

Fig. 2. Injury (incomplete rupture) of anterior talofibular ligament

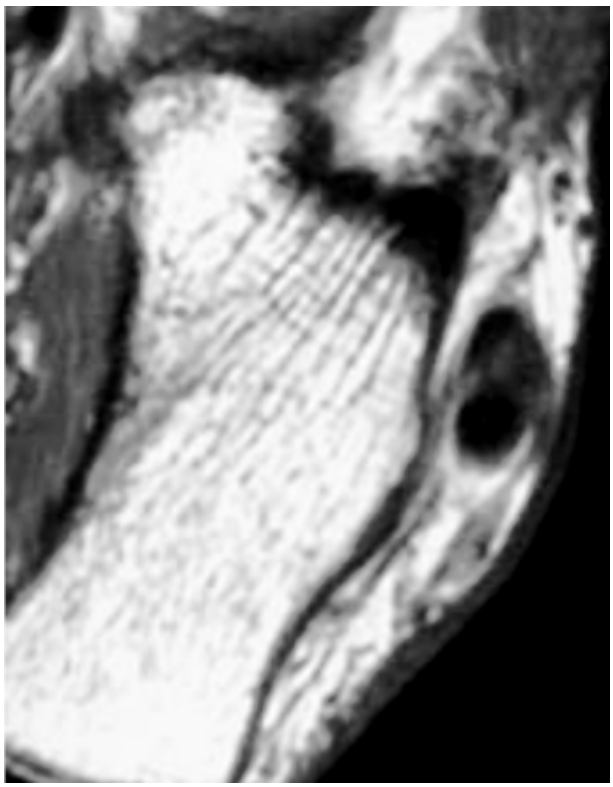

Fig. 3. Injury (incomplete rupture) of peroneal tendon

stress *per* unit of surface, thus giving way to rapid development of osteoarthrosis[1].

The aim of this prospective study was to evaluate the condition of all structures in the area of the upper leg joint, which could sustain injury at distortion.

Our findings obtained by MRI of acute distortion revealed various pathologic transformations occurring in a variety of combinations. None of the injuries was isolated nor there were findings free from pathologic transformations (clinical examination showed degree I-III distortion in all study patients). The pathologic transformations most frequently reconfirmed by MRI in the area of the ligament apparatus corresponded to either sprain of the ligament or joint capsule, or to degree I-III distortion. It was an expected finding in most patients with distortion, with a note that outflow into the joint of a varied severity was recorded in all patients. There were a great number of findings that could have been expected but were not reconfirmed by clinical examination, e.g., occult infraction of the fibular malleolus and talus, sprain or partial injury of the long and short peroneal tendons and of the long toe flexor tendon, as an accompanying injury along with sprain of the lateral collateral ligaments and joint effusion.

Results of the study indicated the presence of radiologically invisible osseous and soft tissue injuries of the joint structures as well as a great variety of the injuries of all the tissue structures in the area of the ankle at distortion. The results suggested that besides ankle injuries, which were expected to be most common considering the typical mechanism of sprain injury (joint effusion, injuries to lateral collateral ligaments and joint capsule), injuries to other soft tissue and osseous structures were just as frequent. And this could not be demonstrated without the use of MRI, supporting the hypothesis that distortions deserve more attention in examination and treatment.

Our results pointed to the necessity of strict compliance with the known principles of treatment for sprain. The patients with persistent discomfort in the ankle area even after appropriate therapy were also recommended to undergo MRI, bearing in mind the real possibility that unrecognized injuries to soft tissues or bones in the area may have existed and late complications occur.

Conclusion

MRI is a diagnostic method that provides a complete and comprehensive insight into the acute injuries of all structures of the ankle, and enables monitoring of the healing process. MRI is the only method that can show osseous edema as a sign of acute lesion. MRI in our circumstances is not a standard screening for the treatment of ankle distortion, however, it is sometimes an unavoidable diagnostic tool to avoid development of chronic discomforts after distortion of the leg joint. Also, MRI has a major role in the diagnosis and treatment of chronic pain and instability of the ankle.

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Sažetak

MAGNETSKA REZONANCA U PROCJENI RAZMJERA OZLJEDE KOD DISTORZIJE SKOČNOG ZGLOBA

Z. Puljiz, A. Matejčić, I. Krolo, A. Aljinović, B.D. Franjić i M. Bekavac Bešlin

Cilj studije bio je procijeniti stanje svih mekih tkiva i koštanih struktura u bolesnika s akutnom ozljedom gležnja pomoću prikaza magnetskom rezonancom (MRI). Tijekom dvogodišnjeg razdoblja (2001. – 2003.) procjena pomoću MRI provedena je u 50 bolesnika s akutnom ozljedom skočnog zgloba (u kojih je koštana ozljeda isključena konvencionalnom radiografijom) unutar 7 dana od nastupa ozljede. MRI je potvrdila slijedeće ozljede: zglobni izljev, ekstenziju zglobne kapsule, ozljedu lateralno kolateralnih ligamenata, infrakciju fibularnog maleolusa, ozljedu tetive dugog palčanog fleksora, ozljedu tetive kratkog i dugog peroneusa, infrakciju talusa i ozljedu tibiofibularne sindesmoze. Dobiveni rezultati pokazali su raznovrsne ozljede kapsulno-ligamentnih i koštanih struktura, kao i postojanje ozljeda nevidljivih na kliničkom pregledu i konvencionalnoj radiografiji, za koje je MRI vrlo korisna dijagnostička metoda u odabranih bolesnika s ozljedom skočnog zgloba.

Ključne riječi: ???