# FEDERATION INTERNATIONALE DE GYMNASTIQUE

## Information médicale

## Medical Information

# Les accidents de la cheville en gymnastique

# Ankle Injuries in Gymnastics

*FIG Mars/March 2010* ©

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# ANKLE INJURIES IN GYMNASTICS

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## Introduction

One of the most common injuries of the musculoskeletal system which occurs frequently in sports medicine and traumatology practice is an injury of ligamentous structures of the ankle, especially on the fibular side of the articulation. The next most common ankle events are fractures, followed by injuries and impairment of the articular cartilage of talus and calcaneus.

The diagnostic algorithm for ankle injury is based on injury mechanism, injury circumstances, symptom evaluation, subsequent clinical development (swelling, haematoma, correlation with clinical tests), physical examination, imaging methods (X-ray examination, ultrasound imaging, MRI) and arthroscopy. Starting the treatment and treatment strategy depend on the type of impairment and time delay from the moment of trauma occurrence.

## Anatomy and biomechanics of ankle

### Ankle joint

Connects lower leg and foot. There are two basic parts of the ankle joint: ***upper part – talocrural and lower part – talocalcaneal.*** Apart from the ligamentous apparatus of the ankle, an important position also belongs to the fixed articulation created by ligaments between the lower parts of the crural bones (distal fibula and tibia) - **syndesmosis tibiofibularis.**

### Ankle ligaments

Ligaments of the ankle have a fan-like shape.

***Lateral side – lateral ligamentous complex:***

1) ligamentum talofibulare anterius (*LFTA)*
2) ligamentum calcaneofibulare (*LFC)*
3) ligamentum talofibulare posterius **(***LFTP)*

***Medial side – medial ligamentous complex:***

1) ligamentum deltoideum
2) ligamentum tibiotalare posterius
3) ligamentum tibiotalare anterius

### Causes of injuries

Any mechanism that exceeds the limits of resistance for ligaments, tendons, muscles and bones may cause injuries. There are many factors that may participate in the genesis of an injury; these factors are often interwoven. Many of them can be affected by prevention (quality of shoes, concentration, sufficient warm-up exercise, quality of sports grounds). However, many factors are out of our control. In gymnastics, it is often a simle accident – the sportsman or athlete lands at the edge of the matt, they

slip under or around the apparatus or they are injured with a misstep on uneven ground. Other factors that may affect the incidence and mechanism of injury in sports can be classified as internal and external:

***Internal factors***

- **Individual predisposition** – anthropological characteristics of the sportsman, in particular the structure and alignment of the bones, muscles and quality of ligament apparatus.
- **Age** – affects the mechanical resistance of the tissue; certain tissues are more prone to injury in certain age categories. Children are susceptible to bone injuries, adolescents to growth cartilage injuries, and adults, are more likely to sustain injuries to ligaments and tendons. The resistance of collagen increases to a maximum at the end of adolescence and decreases with increasing age. The points of ligament and tendon attachment to the bone are critical to all athletes but especially in children and adolescents as many if the injuries occurs there.
- **Sex** –the specific differences between male and female athletes (hyperlaxity, gracility, power, strength, anatomical differences…) need to be accounted for or it may lead to overload injuries caused by incorrect training programmes.
- **Illness** – infectious diseases may be accompanied by secondary changes in locomotive apparatus tissues. Premature and inadequate training in convalescence period, when the illness still has not been cured, may easily lead to overload or balance issues that lead to acute injury.
- **Incomplete healing and rehabilitation** – when pain is suppressed by analgesics or infiltration with anaesthetics and corticosteroids, the sportsman does not feel protective pain in impaired tissues and continues to overload the area. This often makes it worse or repeatedly aggravates the condition. These repeated microtraumas lead to degeneration of the tissue (due to partial ruptures and insufficient blood supply), can lead to further decrease in resistance which may lead to tendon or ligament rupture.
- **Exhaustion** – general and local weariness or exhaustion is obviously connected with a decrease in performance and motion co-ordination disturbances. Exhaustion can cause an athlete to do insufficient training and physical preparation leading to technical errors. The lack of relaxation, rest or recovery time can also lead to insufficient power, strength and endurance for performance and lead to a steep increase in the risk of injury.
- **Improper training and overtraining** – improper training and overtraining are decisive factors that lead to overload injuries and diseases. When training is too frequent and/or too demanding and when it does not correspond to fitness level and health condition, this may lead to overtraining syndrome often manifested as ”chronic fatigue“.
- **Insufficient training** – insufficient preparation for sports performance may lead to the occurrence of injuries and overload impairment, in particular when the sportsman overestimates his/her capabilities.
- **Insufficient warm-up exercise** – insufficient warm-up exercise interferes with motion co-ordination. Cold reduces blood supply to the tissues, reduces the elasticity of tissues, increases muscle tone, and makes the reflexes and muscle contractions slower. Uncoordinated motion is a common mechanism of partial rupture of muscles and impairment of tendons.

- **Impairment of dynamic stereotype** – impairment of function or impaired movement stereotype after a longer break in training may be compensated by other movements, which are often uncoordinated and may lead to injury or overload.
- **Decreased concentration** – lack of concentration during the sport performance and insufficient concentration on the movement may lead to severe injuries in sports.

- **Infringement of sports rules** – principles of correct and safe sports performance have primarily preventive importance; infringement or ignoring of safety and performance rules is often connected with injuries.

***External factors***

- **Gymnasium** – may affect the injuries significantly. The organisers of sporting events are obliged to ensure the best conditions (equipment, mats, floor…). The consequences of cold include muscle stiffness and movement co-ordination disturbances. Excessive heat and humidity can lead to slipping or loss of grip on surfaces, apparatus or athletes.
- **Alcohol** – causes concentration disturbances, lack of critical sense, impairs movement co-ordination, slows down reactions.

**Mechanisms of ankle joint injury**

More than 80 % of all ankle injuries are distortions in inversion. The foot suddenly rotates into plantar flexion and inversion. The sportsman feels sudden sharp pain in the lateral ankle. This mechanism of ankle injury usually damages ligamentum talofibulare anterius (ATF) first. This ligament is also the most commonly injured structure of the ankle. If the mechanism of injury or distortion is more serious (the force continues to act), ligamentum calcaneofibulare (CF) may be injured.

Apart from lateral ligaments, distortion in rotation usually also injures the distal tibiofibular ligaments and membrana interossea. Additional force can also cause a fibular shaft fracture usually at the level that the membrana interossea tear ceases.

The ankle is seldom injured in pure inversion, without plantar flexion and rotation. This injury is quite common after finishing a jump or landing. If more severe force is applied, ligamentum fibulotalare posterius may also be impaired.

Distortion or injury of an ankle in eversion occurs substantially less often than in inversion. This is due mostly to the anatomical structure of the ankle joint and the strength of the deltoid ligament. Distortion in eversion affects specifically the deltoid ligament. If the deltoid ligament cannot absorb the force, then there is usually an avulsion of the medial malleolus rather than a tear of the deltoid. Injuries occurring with eversion force is most frequently associated with strong pronation, abduction and foot dorsiflexion. In such cases, the ligamentum tibiofibulare (syndesmosis) and membrana interossea may also be impaired and fracture of fibula may occur.

After the distortion in dorsiflexion and separation of the syndesmosis, an osteochondral fracture or a fracture of talar neck may often occur. Achilles tendon (tendo calcaneus) may be injured as well.

After the distortion in plantar flexion, the collateral ligaments, tibiofibular ligaments and anterior retinaculum are impaired most frequently. Moreover, this mechanism may impair os trigonum.

**Classification of soft tissue injuries of the ankle**

Sorting into groups according to the severity of ligament apparatus impairment is not uniform (Watson-Jones, Kleiger, Cotler…). The essential differentiation is between partial rupture of ligaments when the stability of is maintained (type I. and II.), and ligament rupture when the ankle is unstable (type III.).

Injury classification of the ligaments is divided into three grades:

- first grade or Type I – distension with fibrillar ligament ruptures
- second grade or Type II – intraligamentous disruption is more pronounced, however, the continuity of the ligament is still maintained
- third grade or Type III – complete rupture of the ligament

According to the international classification of diseases (ICD), soft tissue injuries of the ankle may be divided into two groups:
- S 932 – rupture of the ligaments of ankle and foot
- S 934 – ankle distortion and sprain

Other authors divide the injuries of lateral ligament complex of the ankle into 3 grades, which are defined based on increasing grade of ligament impairment:
- first grade – includes microscopic fissures and LFTA (ATF) distension without direct rupture of the ligament
- second grade – complete rupture of LFTA (ATF) and partial rupture of LFC (CF)
- third grade – includes complete rupture of both LFTA (ATF) and LFC (CF); if accompanied by the rupture of LFTP (PTF), dislocation of the ankle may also be present.

**Diagnostics**

Diagnostics of the severity of soft tissue impairment in the ankle should start by the exploration of the trauma mechanism, the circumstances, swelling and haematoma development; the diagnostics includes clinical tests, common radiography and, possibly, a special imaging examination – stress views or MRI.

**Anamnesis or Patient History**

We make inquiries about the mechanism of the injury, feeling of rupture, whether it was possible to continue the activity etc. Furthermore, we determine the point of primary pain and swelling, we ask how quickly the swelling developed, evaluate the location and scope of the swelling and first aid applied.

**Visual examination and palpation**

Visual examination and palpation should be used for the examination of the whole injured location. The place of maximum pain upon palpation and the scope of secondary changes – oedema and haematoma – should be determined.

**Clinical examination**

The examining physician should never miss the anterior drawer test and the talar tilt test when examining an injury of the ankle.

**Anterior drawer test**

The examining physician stabilises the lower part of the shank or tibia with one hand and holds the heel firmly with the other hand. The examining physician continues to fixate the shank or tibia and draws the heel anteriorly, pushing the foot ventrally. Movement of the talus in front of the ankle joint, which is greater at the injured foot side in comparison to the healthy side, is a positive indication of potential impairment of ligamentum talofibulare anterius.

**Talar tilt test**

The examining physician stabilises the distal part of the shank or tibia with one hand and holds the heel firmly with the other hand. Than he tilts the foot into inversion – pushes the talus into adduction. The inversion of the injured foot is greater than the inversion of the contralateral foot. This finding is an indication of impairment of ligamentum calcaneofibulare.

The tests must be performed within 3 days of the acute injury at the latest. They are not indicated later than a few days post-injury as they may interfere with healing. In such cases, the examination should be postponed until the treatment is finished, i.e. 7 weeks after the injury, when the connective tissue structures are expected to be healed.

**Imaging methods**

Apart from clinical examinations, X-ray and ultrasound imaging should be also performed in persons with ankle injuries. These examinations are necessary to assess the severity of the injury and to determine the subsequent treatment course.

**X-ray examination**

Standard projections of the ankle are required to exclude skeleton injuries. Distension and insufficiency of the ligaments are not visible, must be evaluated in handheld (forced, stressed) positions. CT and MRI scans can be helpful in selected situations.

Fig.1 X-ray forced position talar tilt

Fig.2 X-ray forced position anterior drawer test

**Ultrasound (USG) examination**

Unlike the X-ray examination, USG examination makes it possible for the examining physician to evaluate the condition of the soft tissues in the examined area. A great advantage is echographic visualisation of changes in echogenicity and echostructure over the T-F syndesmosis (hypoechogenic border). Signs of an injury of ligamentum tibiofibulare anterius are able to be seen. The rupture is often directly visible in ligaments bridging the ankle joint; however, the fact that a frank defect is not present does not mean that no injury of the ligament occurred. Distension and insufficiency of the ligaments must be again evaluated in handheld (forced, stressed) positions.

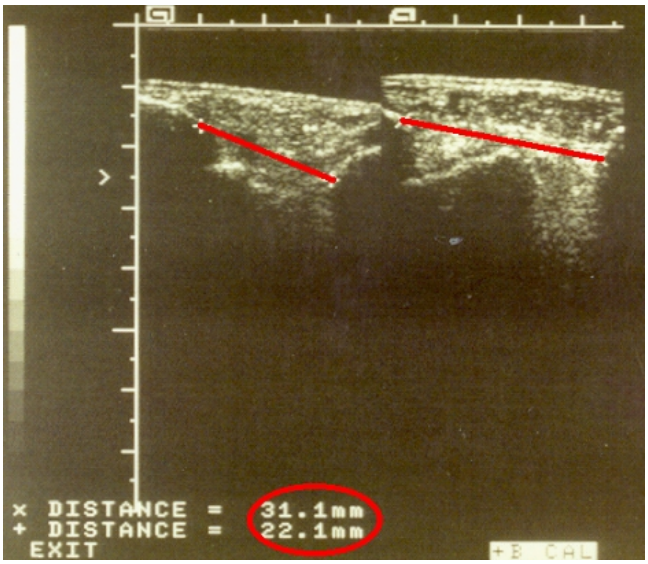


Fig.3 Ultrasound forced position anterior drawer test

## Treatment

### *First aid – RICE (Rest, Ice, Compression, Elevation)*

**Rest**. Injured leg should not bear any load.

**Ice**. Apply cold medium (e.g. ice pack, cooling system, or even frozen vegetables) to the injury location 4–8× daily for 15–20 minutes.

**Compression**. Use elastic bandage for ankle compression. The length of use is proportional to the severity of the injury.

**Elevation**. Ankle elevation reduces the swelling. Ankle should be elevated above the heart level.

The scope of secondary posttraumatic changes (size of haematoma and swelling) directly corresponds to the quality of first aid. If the examination is delayed, the effect of first aid should be taken into account together with the potential severity of the injury.

Supplementary supportive general and local allopathics/ medications: heparinoids, non-steroidal anti-inflammatory drugs, phytotherapy (Aesculus hippocastanum – Alpha aescin, Symphytum peregrini). The advantage of local treatment is absence of generalised or systemic negative side effects. As for oral treatment, we also use systemic enzyme therapy (bromelain).

### Specific treatment of acute distortion of the ankle

Starting the treatment of acute distortion of the ankle without closer specification of the grade of ligament structure impairment is not considered to be „lege artis". It is sometimes difficult to assess the severity of ligament apparatus impairment, either due to significant secondary changes or inability to do an early exam. If the mechanism might suggest a severe distortion, we treat the ankle as if there was a significant ligament disruption.

Treatment decisions are generally based on the severity of the illness and biological behaviour of the healing processes. The treatment may be divided into two categories – 1) rigid immobilization and functional treatment or 2) surgical intervention.

Surgical intervention or treatment requires a proven ligament lesion and appropriate psychosocial condition of the patient. Acute or primary repair of the ligament tear should be done no later than 6 weeks (optimum: within 48 hours) after the injury. This is followed by post-operative rigid immobilization for 6 weeks. Late reconstruction of the ligament apparatus can be done when there is evidence of chronic instability of the joint following conservative treatment..

In acute severe distortions with large swelling, haemarthrosis and severe pain, typical "lege artis" conservative approach is initial application of plaster splint for the period of initial maximum secondary changes (allows for swelling). Plaster fixation is becoming obsolete and is replaced with synthetic (plastic) fixation materials. Rigid plastic circular fixation is lighter, firmer, permeable for air and provides more comfort to the patient; there is a possibility of earlier load with lower risk of damage to the fixation.

After the swelling subsides, completion to circular plaster or fiberglass cast or placement of a fracture orthosis/boot is indicated. Immobilization should be applied for 2–3 weeks after injuries without significant ligament lesions (1$^{st}$ degree injury). and for 6 weeks in complete ligament lesions (3$^{rd}$ degree injury).

Partial ruptures of the ligaments (2$^{nd}$ grade injury) should be treated conservatively with immobilization for 5-6 weeks. They often require rigid immobilization for 3–4 weeks and additional functional immobilization with an air or gel-filled stirrup brace or figure of 8 strap brace for an additional 3-4 weeks.

There are also high rigid ortheses or boots available on the market which sufficiently immobilise the injured region, however, such ortheses may be used only in patients

with high sense of discipline. Patients who are not compliant may take off the orthesis during the sensitive period of healing therefore thay are at high risk of distension or reinjury of the healing structures.
The current trend is functional treatment, which provides better functional results with a shortening of treatment duration. Other treatments are emerging and are considered by some as "state-of-the-art", i.e. the combination of functional treatment and intralesional administration of allopathic medication.

**Hyaluronic acid**– in 2008, a new group of medications belonging into this family was introduced. The active ingredient in this medicinal product is STABHA (Soft Tissue Adapted Hyaluronic Acid). It is highly-purified hyaluronic acid and has no known risk of damage to cell structures. This is the first dosage form that may be applied periarticularly or intratendinously. At present, STABHA is the only medicinal product that may accelerate healing of ankle distortions. There is evidence of statistically significant shortening of the period of healing and decreased incidence of recurrent ankle distortions or injury when compared to the control group.
There is no data to suggest a difference in outcomes whether one chooses surgical or conservative treatment of acute lateral ligament complex injuries in adults. The decision about the method of treatment should always be based on the individual needs of the particular patient. Relative risks and benefits of each option should be carefully evaluated. If we take into account the possibility of postoperative complications and high costs of the surgical treatment, the best option for both the physician and patient is conservative treatment.
The only exception to this is that complete deltoid ligament ruptures should be repaired as they often do poorly with conservative care.

### Treatment of chronic instability of the ankle

Chronic instability of the ankle is usually caused by inadequete treatment of the primary injury, either due to inadequate diagnostics, insufficient immobilization, incomplete rehabilitation or patient-caused factors. The patient can be non-compliant with immobilization, taking off the cast or boot too often, reinjury by premature return to activity or perhaps they did not seek medical care at all. Only in rare cases does this condition develop gradually, due to microtrauma caused by a series of small insults. More commonly, chronic instability is caused by macrotrauma due to recurrent relatively intense insults or sprains over time.

The treatment of chronic instability has often been controversial. There are many procedures and techniques described for the treatment of the damaged lateral ankle ligament complex, however, a consensus surgical solution has not yet been found.

More than 50 surgical procedures for LFTA reconstruction have been published so far. Some of them have been used widely – e.g. the reconstruction according to Evans, Watson-Jones (with unsatisfactory long-term results), Chrisman-Snooke (with satisfactory long-term results) and others. The modified Broström or similar anatomical reconstruction of the ligament is a simple procedure with good short and long-term results. These usually involve shortening, reinsertion and roof-like overlapping of healing elongated structures and it may often represent a more favourable alternative to more complex reconstruction procedures.

### Physiotherapy and rehabilitation

Therapeutic physical training is one of the main methods both in conservative treatment and in late phases of healing after surgery.
Balance plays an important role in many cases of impaired ankle joint functional instability. If the external lateral ligaments are chronically overloaded, the tension receptors in tendons have a delayed response. so the compensatory muscle reactions also occur with delay. Balance exercises improve proprioception and ankle joint stability by using unstable surfaces in a controlled setting to retrain the injured

tissues. These surfaces of use a BAPS board or aids shaped as cylinder or sphere segments. Indications for the use of balance exercises are functional instability of the ankle, disturbances of foot alignment of statics, posttraumatic and/or postoperative conditions of the ankle. The above-mentioned exercises require intense co-operation with the patients and also strong motivation. Minimally 15 to 20 re-education exercise units or therapy sessions, 30-60 minutes each, are necessary, including the breaks for relaxation.

This method allows us to achieve reflexive, automatic activation of the desired muscles at the level of subcortical regulation centres. The method uses the facilitation of proprioceptors of several basal regions that affect the control of posture and activation of spino-cerebello-vestibular tracts (CNS). Basal movement patterns, as e.g. posture and gait, can be affected by this method. The method works with the facilitation of skin receptors, receptors in the sole of the foot and neck muscles. The indications are broad and include not only instability of ankle joint, but also instability of knee, chronic vertebrogenic pain syndrome and impaired posture. When this method is used, a wide spectrum of aids are used – balance aids shaped as cylinder or sphere segments, balance sandals, revolving plates, swingers, mini-trampolines, balance balls, overballs, bosa steps and balance lenses.

**Compensatory exercises**

We include compensatory exercises into each exercise unit for the purposes of primary and secondary prevention of ankle injuries. Compensation exercises may be divided into:

- relaxation exercises – they use slow rotation movements to prepare the segment for the main exercise; the patient never goes into extreme positions in relaxation exercises
- stretching – from the broad spectrum of stretching exercises, we usually use stretching of m. triceps surae to prevent overloading of this muscle
- toning exercises – based on therapeutic physical training; we use balance exercises to improve articular proprioception and stabilisation of the ankle; toning of m. triceps surae (gastrosoleus complex), m. tibialis anterior and plantar muscles of the foot is also recommended.

**Osteopathic manipulative treatment**

Osteopathic manipulative treatment in addition to standard procedures reduces the extent of swelling, pain and improves the extent of motion, in particular in mild forms of distortion or injury. It is recommended to perform lymphatic drainage to evacuate the oedema, manipulations with fibula and os cuboideum using soft tissue techniques are also used.

**Physical treatment**

The following methods of physical treatment are preferred: cryotherapy, galvanisation in rest position, diadynamic currents and magnetotherapy.

**Taping**

Taping is a preventive or curative measure which stabilises the joint using adhesive tape fixation. Taping is often used in sports medicine to support correct function of joints and muscles. At present it is so wide-spread that taping is applied not only by physicians but also by masseurs, physiotherapist athletic trainers and the sportsmen themselves. Taping reduces the load of the locomotive apparatus and prevents extreme positions of the joints during the movement. However, the locomotive apparatus is not the only area affected by this method. The second important function of taping is stimulation of proprioception and central nervous system and positive effect on the mental state of the sportsman.

The aim of ankle taping is to increase mobility under the conditions of controlled stability.

Fig.4 the effects of taping *(Beiersdorf Medical Bibliothek)*

Taping may be used for preventive reduction of load borne by the ligament apparatus and for joint fixation (preventing extreme positions while maintaining the functions). The compressive effect of taping is used for suppression or minimisation of extravasation or swelling in acute injury.

**Bandages and orthoses**

The use of bandages and orthoses in sports medicine tends to increase. Bandages and orthoses are used not only for preventive purposes, but also for conservative functional treatment, acceleration of healing, stabilisation of chronic ankle instability and prevention of secondary injury in areas of acute ankle injury. Bandages are usually soft with a lining surrounding the injury location; the load of the injured region is reduced by elimination of local pressure and transmission of the force to the surroundings. Unlike bandages, orthoses are made of more rigid materials supplemented with tape for fixation. The purpose of orthoses is to limit the extent of the motion and prevent extreme positions of the ankle.

Bandages and orthoses are also used for their thermic effect, positive effect on blood supply to the bandaged region, andioedematous and myorelaxation effects, changes in biomechanics and stimulation of proprioception.

Bandages and braces support or modify the function of the treated anatomic region, therefore, the prescribing physician must be familiar with the characteristics and use of the respective models. Each aid must be chosen on individual basis, according to the needs of the particular sportsman and according to the type of injury and, last but not least, the character of the sport.

Fig.5 ankle brace *http://www.sanomed.cz/cz/katalog/kotnik/item-0006919*

**Conclusion**

Ankle distortion or the injury of soft tissues of the ankle is a common condition which occurs frequently in the everyday practice of orthopedists, traumatologists and general surgery practitioners. Despite the frequent occurrence of this injury, the

treatment is frequently inadequate. As in most other sports, ankle injuries or distortions are one of the most common injuries in gymnastics.
Injuries to the ankle have tremendous epidemiological significance and account for approximately 20% of all soft tissue injuries of the locomotive apparatus. They are so common, that they are often trivialised. It is important to highlight that lege artis examination and treatment are the only correct ways to treat ankle injuries . This article represents an effort to summarise the diagnostic and treatment methods.

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Thanks to Dr. Leglise Michel and Dr.Binder A. Jay for kind supervision and correction.