

Ankle ligament injury: current concept

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Abstract

Introduction

Acute ankle injuries during sports activities or social life are among the most commonly seen pathologies in the clinical practice of orthopaedic traumatology. The aim of this review was to discuss ankle ligament injury.

Conclusion

Approximately 20% of acute ankle sprains may develop chronic functional or mechanical instability. There is still no established consensus on the prevention and the optimal treatment algorithm for acute ankle injuries. Primary clinical approach is the functional rehabilitation protocol in the management of acute ankle injuries. Surgical repair is indicated in particular patients who actively participate in high-demand sports activities and the ones with symptomatic mechanical instability following a failed functional treatment. Non-anatomic reconstructions should be avoided because of high incidence of impaired ankle biomechanics.

Introduction

Acute ankle injuries during sports activities or social life are among the most commonly seen pathologies in the clinical practice of orthopaedic traumatology¹. These injuries constitute nearly 40% of sports-related trauma cases and 25% of all musculoskeletal trauma cases²⁻⁴. Ligamentous

lesions are also diagnosed as concomitant injuries in 75% of patients with acute ankle problems⁵. It usually is incurred from an inversion force on the ankle, but eversion forces also can traumatise the ankle⁶. Because of increasing participation in sporting events, health care professionals involved in the care of athletes at all levels must have a thorough understanding of the anatomy, pathophysiology and initial management of ankle injuries⁷. Ankle sprains were found to be the most common injuries among high school athletes⁸. Clinical approach includes evaluation of the cases to determine the ones who need radiographic imaging, exclusion of bone and joint injuries as differential diagnosis, and application of the most appropriate treatment according to degree of the ligamentous injury. Ankle sprain injuries may be underestimated in daily clinical practice by some of the surgeons. However, it has been reported in different studies that acute sprains may have a potential risk of evolving into a chronic problem⁹⁻¹³. Eighty percent of acute ankle sprains recover following conservative management, whereas 20% of acute ankle sprains were found to be resulting in chronic instability^{4,14,15}. Degenerative changes in the ankle joint are generally the final result of this chronic instability. This review discusses the current concept of ankle ligament injury.

Discussion

The authors have referenced some of their own studies in this review. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964) and the protocols of these studies have been approved by the relevant ethics committees related to the institution

in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies.

Functional anatomy

Stability of the ankle is due to bony configuration of the ankle mortise and talar dome, ligamentous structures, capsule, syndesmosis and the crossing tendons¹⁶. Medial and lateral collateral ligaments together with syndesmosis dynamically contribute to biomechanical stability in every step of motion.

Lateral collateral ligament complex

The lateral collateral ligamentous complex of the ankle joint is composed of the anterior talofibular ligament (ATFL), the calcaneofibular ligament (CFL) and the posterior talofibular ligament (PTFL). The ATFL forms a 47° angle to the sagittal plane and 25° angle to the horizontal plane and is the primary restraint against plantar flexion and internal rotation of the foot^{17,18}. Anterior talofibular ligament, which measures nearly 10 mm in length and 2 mm in thickness, is the weakest and the mostly injured part of the lateral collateral ligamentous complex¹⁷. The main function of the ATFL is to resist torsion and inversion stresses in a plantar-flexed foot. CFL, which lies between the tip of the fibula and calcaneus, is the only extra-articular component. The CFL forms a 133° angle with the fibula and a 104° angle with the ATFL^{17,18}. Its main function is to resist torsion and inversion stresses in a dorsalflexed foot. The PTFL plays a role in limiting the posterior movement of the talus and is the strongest component of the lateral ligamentous complex¹⁷.

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Medial collateral ligament complex

The deltoid ligament is the only stabiliser of the medial side of the ankle joint. This ligamentous complex is composed of two layers: superficial and deep. The superficial layer includes tibionavicular, tibiocalcaneal and posterior talotibial ligaments, whereas the deep layer includes deep anterior talotibial and deep posterior talotibial ligaments. The deep layer is more important in the aspect of contribution to whole joint stability. The medial side of the ankle is more stable than the lateral side, so that the strength of the ligamentous complex may even lead to fracture of medial malleolus without rupture of the ligamentous fibres.

Syndesmosis

Syndesmosis is a complex structure which is composed of four parts in the distal tibiofibular joint. These four components are antero-inferior tibiofibular ligament, postero-inferior tibiofibular ligament, transverse tibiofibular ligament and interosseous membrane. Synchronised function of these ligamentous structures as distal tibiofibular syndesmosis is crucial for biomechanical stability of the ankle^{12,13,19,20}.

Mechanisms of injury

ATFL followed by the CFL are the mostly injured anatomic structures among ankle ligamentous injuries¹⁶. Broström²¹ surgically explored 105 sprained ankles and found that two-thirds of the ankles had an ATFL tear, while a quarter of the ankles had a combined ATFL and CFL rupture. The most common mechanism of injury occurs with torsion and inversion forces in a plantar-flexed ankle, that is, the situation that bony stability becomes the weakest as the body's centre of gravity rolls over the ankle joint. When the inversion forces occur in a dorsiflexed ankle, primary stabiliser is the CFL and thus, this is the mechanism of injury for the CFL. Deltoid ligament injury is generally

due to eversion together with external rotation, and its complete rupture commonly accompanies with fractures of the ankle⁹. Syndesmotic injuries occur as a result of forced external rotation during dorsiflexion–eversion movement in the ankle. Syndesmotic injury may be in isolation or may be associated with ankle fracture²².

Classification

The classification of ankle sprains is composed of three grades, which are formed according to pathological anatomy, clinical findings and instability, with increasing severity. The classification is important in clinical practice to diagnose and choose the appropriate treatment for the patient. Grade I is a stretching injury without any macroscopic tear. It is generally limited to the ATFL injury. Mild swelling, tenderness and minimal difficulty in range of motion (ROM) characterise the clinical presentation. Grade II includes tear of the ATFL accompanied by partial or complete tear of the CFL. Moderate swelling, ecchymosis, antero-lateral tenderness and restriction of ROM are the clinical findings. Grade III is the most severe type which includes tear of the ATFL and CFL with or without capsular tear as well as the PTFL. Diffuse swelling, ecchymosis, tenderness and inability of weight bearing are present with significant instability in the clinical examination. Deltoid ligament injury is also diagnosed in 10% of the cases with serious inversion trauma.

Syndesmotic injuries are assessed particularly because of its unique biomechanical features and the differences in the treatment approach. These injuries are generally related to the level of distal fibular fracture. Lesion of the syndesmosis is evident in the half of Weber type B and most of Weber type C distal fibular fractures. Additionally, it is the first anatomic structure to be damaged in supination–eversion and also pronation–eversion injuries

according to the Lauge–Hansen classification of ankle fractures. Ankle syndesmotic injury does not necessarily lead to ankle instability; however, the coexistence of deltoid ligament injury critically destabilises the ankle joint²².

Clinical presentation

A detailed history of the incident and a careful physical examination of the patient are the primary steps when evaluating an acute ankle sprain. Previous history of similar injuries is also important. Personal feeling of 'rolling over' in the injured ankle joint is generally the situation that the patient describes about the mechanism of injury. Acute pain, inability to walk and acute swelling may also be reported by the patient.

Clinical tools are used in particular to identify areas of pain and for comparative analysis of mobility and any laxity in ligament testing²³. Physical examination of such a patient with acute ankle sprain in routine clinical practice of traumatology should always include inspection of any swelling, ecchymosis or deformity of the ankle, careful palpation to localise the pain and tenderness and evaluation of ROM. Careful palpation of the critical anatomic check-points can provide information to confirm affected structures (Figure 1). A typical walking pattern to protect their ankle and avoid further pain, the patients may adapt the situation. Mild swelling, tenderness and minimal difficulty in ROM characterise the clinical presentation in Grade I injuries. However, diffuse swelling, ecchymosis, tenderness and inability of weight bearing are present with significant instability in the clinical examination of a Grade III injury. Haemarthrosis may also complicate the clinical presentation. Pain, swelling and tenderness on the medial side of the injured ankle as well as a defect in the soft tissues palpated just distal to medial malleolus may indicate possible deltoid ligament injury. Syndesmotic injury is also a very important

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Figure 1: Check tenderness points according to OAR: (a) the distal medial malleolus; (b) the navicular bone; (c) the distal lateral malleolus and (d) the proximal fifth metatarsal. OAR, Ottawa Ankle Rules.

pathology which may be clinically suspected during physical examination. In the absence of fracture, physical examination findings suggestive of injury include ankle tenderness over the anterior aspect of the syndesmosis and a positive squeeze or external rotation test²². Assessment of the patient's neurovascular status in the injured extremity should also be included as an important step in the physical examination⁵.

On physical examination, the use of stress testing is useful (Table 1). Anterior drawer test and talar tilt test are the two provocative tests in physical examination to evaluate any clinical instability. The anterior drawer test is used to assess the

ATFL as it prevents anterior translation of talus under distal tibia. Ten millimetres of displacement in the injured ankle or more than 3 mm of difference in translation compared with healthy side indicates the ATFL tear. The talar tilt test is described as the angle formed by the talar dome and the tibial plafond during forced hindfoot inversion with the tibiotalar joint held in neutral¹⁶. The test is generally used as a stress radiograph rather than a physical examination method.

Differential diagnosis

Differential diagnosis of any ligamentous injury of the ankle includes bony, tendinous or joint pathologies

around the ankle. Fracture of the anterior process of calcaneus, lateral process of talus, base of the fifth metatarsal, osteochondral fracture of the talar dome and dislocation of the subtalar joint should be excluded in such patients. Additionally, it should be noted that physeal injuries around the ankle in pre-pubertal age group may present with similar clinical findings⁹. Tendon injuries such as displacement of the peroneus longus and brevis due to torn fibrous retinaculum holding them in proper anatomic localisation, or the rupture of tibialis posterior tendon should also be kept in mind in the differential diagnosis²⁴.

Diagnostic studies

The first step following clinical examination in the assessment of an ankle injury is the standard radiographic imaging to rule out any fracture. Decision on the necessity of radiographic imaging is made by the clinical use of Ottawa Ankle Rules (OAR) established by Stiell et al.²⁵ According to OAR, radiographic images are obtained if any of the described signs is present²⁶. Initial radiographic imaging of the ankle joint includes anteroposterior (AP), lateral and mortise view. There are also radiological tests,

Table 1 Summary of the tests applied in physical examination and the anatomic structures that are evaluated

Test	Evaluated tissue	Application	Result
Anterior drawer	ATFL	Anterior movement of talus during the forward propulsion of the heel when distal tibia is stabilised	Increased anterior translation of talus compared with contra-lateral more than 4 mm: ATFL tear
Talar tilt	CFL	Measurement of the angle between talar dome and tibial plafond during forced inversion of the ankle while distal tibia is stabilised	More than 5° of difference in outward shift compared with contra-lateral side: CFL tear
Eversion stress	Deltoid ligament	Abduction with eversion of the ankle while tibia is stabilised	Increased laxity compared with contra-lateral side: Deltoid ligament injury
External rotation stress	Syndesmosis	Plantar flexion and external rotation of the ankle while tibia is stabilised	Pain and tenderness indicate syndesmotomic injury

ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament.

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weight-bearing plain X-ray (stress X-ray), (alignment of the hindfoot, with a meary view [metal wire circling the heel], arthrosis) and dynamic images to confirm and quantify laxity (manually, with a Telos device, with patient-controlled varus) to identify ligament, tendon and cartilage damages²³. AP and mortise views in dorsal-flexed and plantar-flexed ankles may provide information about any possible osteochondral lesions of the talus. Furthermore, oblique foot X-ray should also be obtained in the presence of tenderness on the proximal part of the fifth metatarsal. Although its validity is not clear, stress roentgenographs can be used as a component of diagnostic work-up. When evaluating the Deltoid ligament injury, AP and lateral radiographs of the ankle in a 20° internally rotated position as well as the valgus stress radiograph may also be useful. A positive squeeze test and/or external rotation test may also indicate a syndesmotic injury, thus it should be kept in mind that radiographic evaluation of syndesmosis is also crucial in the case of a clinical suspicion²⁵. More than 10° of valgus tilt and/or more than 5 mm of widening in the medial clear space are accepted as pathologic. Radiographic findings of syndesmotic injury usually include increased tibiofibular clear space, decreased tibiofibular overlap and increased medial clear space; however, syndesmotic injury may not always be apparent radiographically²².

Ultrasound may also be used in the diagnostic work-up of ankle ligament injuries. However, it has two important handicaps: first, acute tears may be visualised in different forms such as swelling or hypoechogenicity, which may not provide sufficient information for accurate diagnosis and second, it is highly dependent on equipment and/or the operator. Diagnostic accuracy of this technique was demonstrated as up to 95% for ATFL injuries and 90% for CFL injuries²⁷.

Magnetic resonance imaging (MRI) is not routinely indicated in acute ankle injuries unless there is a major acute instability. However, MRI may be very useful in some particular patients with clinically suspected concomitant injuries to establish a differential diagnosis (i.e. osteochondral lesions and tendinous pathologies). MRI is generally indicated in the presence of chronicity of the complaints following an acute ankle injury, a clinical history of repetitive trauma and complex injuries of the ankle including multiple pathologies.

Although they are not routinely included in diagnostic work-up, computerised tomography arthrogram, gadolinium enhanced MRI, magnetic resonance arthrogram or scintigraphy are also the sophisticated imaging techniques, which may be helpful in the assessment of particular patients.

Treatment

The first principle of the treatment in such kind of injuries is the prevention¹⁶. There are different studies that evaluated the role of methods for avoiding of ankle sprains; however, a consensus that is agreed on has not been established yet in the scientific level, and thus ideal prevention method is still controversial.

Non-surgical measures, including functional rehabilitation, are the management methods of choice for acute injuries¹. Combination of rest, ice, compression and elevation (RICE) is the first treatment in ankle sprains. Sloan et al.²⁸ reported that cold application together with compression, which are supported by non-steroid anti-inflammatory drugs, are more effective in controlling soft tissue oedema. Grade I and Grade II injuries, which constitute most of the cases, are treated conservatively; however many times, this injury is taken for granted because of the frequency of its presentation⁶. Conservative treatment of acute ankle injuries is composed

of four stages, which are named together as the functional rehabilitation protocol. Its main principle is to improve proprioception as the ROM is maintained during the process of soft tissue healing. The first stage is the RICE of which the primary aim is to reduce inflammation and soft tissue oedema. The second stage, which aims protection of the injured ligaments during the healing process, includes the application of an ankle splint or bracing for up to 3 weeks. It is demonstrated that bracing can decrease talar tilt on the roentgenographs²⁹. The third stage, which begins by the end of the 3rd week of the injury, includes controlled isometric and concentric stretching exercises to prevent joint stiffness that may occur due to scar tissue at the healing side. The final stage of the functional rehabilitation protocol is the one that the patient returns to pre-injury level of full activity by the end of 6–8 weeks of the injury. Strengthening exercises should be continued following regain of a pain-free ankle with a normalised weight-bearing as the pre-injury level. Treatment of Grade III ankle sprains is controversial. In other words, there is no ascertained algorithm for such kind of injuries¹⁶. Failed non-surgical management after appropriate rehabilitation is an indication for surgery. Acute surgical repair is generally recommended for high-demand athletes¹. Furthermore, of the many surgical options available, anatomic repair of the ATFL and CFL is recommended when the quality of the ruptured ligaments permits¹. Leach and Schepsis³⁰ advocated primary repair in young athletes with Grade III sprains. A review of 12 prospective studies demonstrated that functional treatment revealed better results in the aspect of return to work than acute surgical repair³¹. Additionally, clinical results of secondary repair are similar to that of functional treatment, and thus surgical treatment for an acute injury is not a routine indication. As a clinical

approach, functional treatment of a standard patient who is not an active, high-demand athlete seems to be better than acute primary repair.

Platelet-rich plasma (PRP) injection has been studied and used for the treatment of tendon injuries, chronic wounds, ligamentous injuries, cartilage injuries, muscle injuries and bone augmentation³². The results from *in vitro* and *in vivo* studies in foot and ankle injuries are promising. Therefore, PRP should also be kept in mind as an additional supportive intervention when conservatively treating an ankle injury.

Although appropriate treatment is applied as initial care, the patient may experience continued or residual pain⁶. Indications for surgical treatment are symptomatic of persistent mechanical instability following failed functional treatment and acute instability in patients dealing with high-demand sports activity. Functional rehabilitation protocol may fail in patients with mechanical instability, peroneal weakness or proprioceptive deficit. Surgical treatment options mainly include primary repair, secondary anatomic reconstruction and secondary non-anatomic reconstruction. Surgical repair of any collateral ligament injury is done with three types of procedures: tightening the capsuloligamentous structures, ligament reconstruction with reinforcement (using the fibrous periosteum, the ligament of Retzius or tendinous reconstruction with the plantaris muscle, the peroneus tertius or even the calcaneal tendon) and tendon transfer procedures using all or part of the peroneus brevis²³. Anatomic reconstruction with autograft or allograft should be performed when the ruptured ligaments are attenuated¹. A subset of patients, however, are subject to increased failure rates, including those with long-standing instability, poor tissue quality, history of previous repair, generalised ligamentous laxity and cavovarus foot deformity¹⁶. Non-anatomic tenodeses

are not recommended because they may cause a permanent impairment of ankle and hindfoot biomechanics¹.

Deltoid ligament injuries are generally treated by conservative methods as in the collateral injuries, except the ones with medial malleolar fracture with medial ankle instability resulting from an acute complete tear³³. In syndesmotic injuries, main goals of management are to restore and maintain the normal tibiofibular relationship to allow for healing of the ligamentous structures of the syndesmosis²². More than 10° of valgus tilt and/or more than 5 mm of widening in the medial clear space are accepted as pathologic for syndesmotic injury, and the surgical treatment is indicated.

Conclusion

Acute ankle injuries during sports activities or social life are among the most commonly seen pathologies in the clinical practice of orthopaedic traumatology. Approximately, 20% of acute ankle sprains may develop chronic functional or mechanical instability. There is still no established consensus on the prevention and the optimal treatment algorithm for acute ankle injuries. Primary clinical approach is the functional rehabilitation protocol in the management of acute ankle injuries. Surgical repair is indicated in particular patients who actively participate in high-demand sports activities and the ones with symptomatic mechanical instability following a failed functional treatment. Non-anatomic reconstructions should be avoided because of high incidence of impaired ankle biomechanics.

Abbreviations list

AP, antero-posterior; ATFL, anterior talofibular ligament; CFL, calcaneofibular ligament; MRI, magnetic resonance imaging; OAR, Ottawa Ankle Rules; PRP, platelet-rich plasma; PTFL, posterior talofibular ligament; RICE, rest, ice, compression and elevation; ROM, range of motion.

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