Ankle instability – review and new trends

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Abstract
Ankle instability is an old topic with increasing importance in Orthopaedics’ world, as we start now realising how under-diagnosed this pathology has been. A lot of effort has been made in recent years to better understand the pathomechanics of this injury, with new surgical techniques being tried and even new anatomic structures being described. The objective of this paper is to review and compile the most important and recent literature on this matter, in an academic way, but oriented to clinical practice, so it can help surgeons keep updated in this so important subject.

Keywords
Ankle, ankle instability, chronic ankle instability, ankle arthroscopy

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Introduction
Ankle instability is an old topic with increasing importance in Orthopaedics’ world, as we start now realising how under-diagnosed this pathology has been. A lot of effort has been made in recent years to better understand the pathomechanics of this injury, with new surgical techniques being tried and even new anatomic structures being described.

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Epidemiology
Ankle sprains account for 10–30% of all sports injuries. Its incidence peak locates between 15 and 19 years old representing 50% of all lower limb lesions in high school athletes. Inversion-type is by far the most common mechanism of injury happening in 80–90% of cases. Compared with men, women have a slightly higher overall incidence of ankle injuries in similar sports activities. Men, however, have a higher incidence of medial ankle and syndesmotic sprains. Greater mean height and weight, increased body mass index, and certain athletic activities (e.g. basketball, football, rugby) may be risk factors for ankle sprains as well.1,2

Anatomy and mechanism of injury

Bony anatomy
Several bony structures of the ankle are of the utmost importance contributing up to 30% of ankle resistance to rotation.3 The morphology of the talus, being broader anterior than posterior increases joint stability at neutral position and predisposes for supination-inversion sprains. Posterior position of the fibula and hindfoot malalignment also have been shown to predisposes to ankle instability,4 and the length of the medial malleoli has been shown to relate with the number and the severity of ankle sprains.5

Soft-tissue anatomy
The deltoid ligament complex is composed of a superficial layer, a deep layer and the spring (calcaneonavicular) ligament. The spring ligament is often included with the deltoid

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ligament complex because it assists in stabilising the medial ankle structures of the ankle joint through its connection to the deltoid by the tibiospring ligament.

Laterally, the ligament complex is composed by the anterior talofibular ligament (ATFL) superior and inferior fascicles, the calcaneofibular ligament (CFL) and posterior talofibular ligament (PTFL). The inferior ATFL fascicle and the CFL share the same fibular insertion and are connected by the arciform fibres representing a single functional structure that acts as a ligamentous complex. Thus, the lateral fibulotalocalcaneal ligament complex is a more accurate terminology for this structure. In addition, ATFL’s superior fascicle is an intra-articular structure while ATFL’s inferior fascicle is extra-articular.7

Regarding the subtalar joint, increasing interest has been given to the cervical ligament as many authors purpose it to be a source of both pain and instability symptoms.

Mechanism of injury

An inversion ankle sprain is the most frequent cause of acute ankle injury in sports.8 This typically occurs after a jump, when landing on the lateral border of the foot, but might also occur if the foot gets locked on the ground, while the body continues to turn. This sudden increase in inversion and internal rotation forces, combined with either dorsiflexion or plantarflexion, produces sufficient strains to rupture the ankle lateral ligaments, causes concomitant osteochondral lesions or aggravates anterior or posterior joint impingement. The ATFL ruptures first and usually is the only ligament injured.8 This is due to the fact that the ATFL is the weakest component of the lateral collateral ligament complex of the ankle, in particular its superior fascicle.9,10 With higher deforming forces, the injury continues to propagate rupturing the inferior ATFL fascicle and the CFL.1,2 Finally, continuous energy will rupture the PTFL causing the ankle to dislocate laterally. In about 65–80% of cases, an isolated lesion of the ATFL will occur, while combined ruptures of the ATFL and CFL happen in around 20%.8,9 The PTFL is rarely injured during inversion sprain.10,11 In ~10–15% of all inversion injuries, there is a total rupture of the lateral ankle ligaments.7

Patients with medial ankle instability may give a history of a pronation-type injury, but more often report having had multiple ankle sprains without clearly remembering the mechanism. Deltoid injuries occur commonly in relation to fractures such as Wb C/pronation external rotation or pronation abduction and less frequently with Wb B/supination external rotation ankle fractures.

Ankle instability

Functional instability

A history of insecurity, a feeling of instability, and giving way is far more common in the diagnosis than demonstrable instability on physical examination or stress radiographs. The presence of damaged proprioception nerve receptors located in the ligaments and skin is responsible for this clinical presentation. Delay in muscle reactivity, namely by the peroneal muscles, can also contribute to this type of instability.12,13

Mechanical instability

Mechanical instability is characterised by true insufficiency of the ligamentous stabilisers with objective evidence of ligamentous laxity on the physical exam. Specific tests can be done in order to better understand which structures might be compromised. Those tests will be described later in this text.

Rotatory ankle instability (RAI) is a category that combines lateral and medial instability. Under weight-bearing conditions, ATFL-deficient ankles demonstrate increased anterior translation, internal rotation and superior translation of the talus.6 These biomechanical changes are associated with the development of degenerative arthritis. CAI may also cause concomitant ankle injuries, leading to a deltoid ligament tear. RAI should be considered when an injury is present in the anterior fibres of the deltoid ligament. It is estimated that 10–40% of all patients affected by CAI have a partial deltoid injury.9,10

Microinstability is an emerging concept within mechanical ankle instability, and the currently proposed pathomechanism is a partial tear of the ATFL affecting only the superior fascicle of the ligament.11 As recently reported, ATFL’s superior fascicle is an intra-articular structure.7 Because of this anatomic characteristic, proper healing of ATFL’s superior fascicle is limited as intra-articular ligaments do not heal by themselves. At an increased risk of ankle sprain recurrence, these patients can go on to develop chronic ankle instability (CAI) or classical ankle instability caused by ligament tear propagation affecting the ATFL’s inferior fascicle and calcaneofibular ligament. Therefore, ankle microinstability should be considered as initial and developing ankle instability.14

Diagnose

The history should address the mechanism of the most recent injury, the ability to bear weight, the frequency of instability episodes and ankle sprains, and previous treatments. The physical examination includes an evaluation of gait and standing alignment, during which the examiner looks for varus hindfoot alignment, which leads to lateral foot overload and can result in ankle instability, peroneal tendon injury and fifth metatarsal stress fracture. Special tests are used to diagnose this pathology include the inversion and eversion test, external rotation test, anterior drawer test and Squeeze test.

Frey et al.15 found that physical examination was 100% accurate in the diagnosis of grade III ligament injuries but only 25% accurate in the diagnosis of grade II injuries.
X-ray

Standard plain radiographs should include standing anteroposterior, lateral and mortise views and a comparative Saltzmann view can be useful as well. Dynamic stress X-rays only have diagnostic value if they are positive, with specificity (up to 100%) but low sensitivity (57%).17,18

Magnetic resonance imaging

More powerful and three-dimensional MRI studies have allowed for greater accuracy in the diagnosis of ankle and hindfoot injuries.19 Axial MRI with a local gradient provides optimal views of the ATFL and PFtFL, the deep layers of the medial collateral ligament, and the tibionavicular ligament, whereas MRI coronal imaging allows a complete view of the calcaneofibular, posterior talofibular, tibiocalcaneal and posterior tibiotalar ligaments. In both imaging planes, differentiation of the deep and superficial layers of the medial collateral ligament, as well as between the syndesmotic complex and the lateral collateral ligaments, was possible. MRI has been shown to be effective by several authors in identifying and differentiating lateral ankle ligament injuries; however, many believe that the costs outweigh the benefits. If a peroneal pathologic process is suspected, MRI may be beneficial, but it should not be used routinely to diagnose lateral ligament injury.5

Ultrasonography

Ultrasonography (US) plays a significant role in evaluating the ankle ligaments. The ligaments are hyperechoic when oriented parallel to the US beam. US is more useful in acute ligamentous injuries, with an accuracy of up to 93.8% sensitivity and a 100% specificity in detecting ATFL tears when compared with MRI. In addition, dynamic US can be performed, assessing for ankle ligament stability and bony impingement in real time using joint stress manoeuvres. However, a skilled and experienced operator is necessary to obtain such results.20,21

Arthroscopy

There are several studies highlighting the importance of arthroscopy in the diagnosis and treatment of ankle instability due to the amount of concomitant injuries that is possible to find inside the joint that would pass undiagnosed otherwise. Classic studies like Hintermann et al.9 that was able to find cartilage injury in 66% of patients with lateral ankle instability and in 98% of cases of medial instability enhancing the diagnose from 4% pre op to >50% post op, or Okuda et al.22 that found 63% chondral lesions undergoing arthroscopy prior to ligament reconstruction, are being continuously supported by more recent papers like Vega et al.23 where they found intra-articular ankle problems in 100% of the patients (Table 1). Nowadays, arthroscopy evaluation is considered the most important prognostic factor and, because of this, a thorough arthroscopic evaluation, as well as treatment of any intra-articular pathology, prior to ligament surgery, is recommended by most authors.17,24 The treatment of concomitant injuries is beyond the scope of this review.

Treatment

Although the natural history of ankle sprains is not completely understood, the inherent stability of the ankle mortice and its congruency might contribute to the fact that complete but isolated ATFL ruptures have a good prognosis. Most patients are successfully treated with functional treatment.25 In some selected cases, especially in elite athletes, it has been proposed that early surgery can be considered as a first-line treatment to achieve a faster return to play.26,27

Non-operative

Optimal management of an ankle sprain is still unclear. Although there is an enormous amount of studies regarding CAI conservative treatment, the heterogeneity of them makes it difficult to make high-quality evidence recommendations. A 2017 meta-analysis28 failed to clear this topic beyond reaching strong evidence for exercise therapy and bracing in preventing ankle sprain recurrence. Most experts recommend functional rehabilitation and the use of bracing or taping. Rehabilitative exercises include proprioceptive training and evertor (peroneus brevis) strengthening. Ankle bracing or taping improves mechanical and functional stability in athletes with CAI. Both taping and bracing restrict range of motion, reduce

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Table 1. Concomitant injuries.

| Table 1. Concomitant injuries.                      | (100%) |
|---------------------------------------------------|--------|
| Intra-articular ankle problem in 24 patients       | (100%) |
| Soft-tissue impingement                           | 22 (91.7%) |
| Deltoid ‘open book’ tear                          | 14 (58.3%) |
| Distal tibia bony impingement                     | 13 (54.2%) |
| Loose body                                        | 5 (20.8%) |
| Medial talar osteochondral defect                 | 5 (20.8%) |
| Moderated osteoarthritis                         | 2 (8.3%) |
| Extra-articular problems around the ankle in 14 patients | 58.3% |
| Peroneal tendons complaint                        | 14 (58.3%) |
| Posterior ankle pain                              | 3 (12.5%) |
reinjury rates, improve proprioception, have minimal negative effects on other joints, and do not affect athletic performance. Bracing with an ankle stabilising orthosis (a soft brace that provides compression and has straps crossing the ankle joint) limits varus/valgus angulation and provides proprioceptive feedback that helps to improve active stabilisation by the peroneus brevis. Taping is less bulky than bracing and may cater to unusual anatomy; however, bracing has the advantage of being reusable and easily adjustable. Approximately 80% of patients improve with functional rehabilitation and bracing. Nonsteroidal anti-inflammatory drugs, either taken orally or applied topically, may be used to provide short-term (1–3 weeks) pain relief and a reduction in swelling, but they have no long-term effects on the symptoms of CAI.45 Another important subject withdrawn from the literature is the recommendation of checking whether the non-surgical treatment had been performed properly. If not, it is recommended to restart rehabilitation with most of the surgeons recommending at least 3–6 months of non-surgical treatment.17

Surgical treatment

Despite adequate conservative treatment, around 20–30% of patients will develop CAI with persistent symptoms (fear of reinjury limiting activity, sense of giving away and recurrent sprains). The operative treatments for CAI include a variety of procedures ranging from simple repairs to complex reconstructions. Repairs consist of either reattaching or imbricating (shortening) the injured native tissues, whereas reconstructions involve replacing the ligaments with either autologous or allograft tissue. Furthermore, reconstructions may be either anatomic or nonanatomic.

Lateral chronic instability

Starting with lateral ankle instability, it is important to acknowledge that currently, there is insufficient evidence to support any specific superior surgical intervention in the treatment of lateral CAI. Nevertheless, non-anatomic reconstruction, as the classic Evans, Watson-Jones or Chrisman-Snook procedures, has been shown to significantly alter the normal biomechanics of the ankle complex, particularly the subtalar joint.29,30 Given these concerns,31 and the favourable outcome of anatomic techniques, the former are currently the first line of surgical treatment.17,24,25 Anatomic open repair was first described in 1966 by Brostrom.32 This technique respects the original anatomy by tightening the torn ATFL and CFL to the distal fibula. Several modifications were introduced over time, first by Gould et al.33 that advised to suture the inferior retinaculum extensorum (RE) over the proximal ATFL end to augment the repair, then the modification by Karlsson et al.34 advised to shorten the ligaments that were often not disrupted but elongated. Nowadays some authors advocate that the augmentation with non-absorbable suture tape may allow for less immobilisation and much earlier and aggressive rehabilitation, although there is still plenty of debate on this issue, with some recent studies failing to find any clinical advantage compared with the standard procedure.35–38 The most recent high-quality study regarding this open technique was a Level I randomised trial published by Ko et al.39 in 2018 that reinforced the recent trend addressing only the ATFL accomplishing the same results as those who addressed both ATFL and CFL.31,40–42 The functional outcomes of these techniques in their many modifications have been classified as excellent, with success rates of 87–95%.33,34,43 All the anatomic repair techniques depend on the quality of the ligaments’ remnant in order to achieve an effective repair. Karlsson et al.34 determined risk factors for the worst outcome: hyperlaxity, long-standing injuries and previous surgical treatment. The current trend on the pursuit of minimally invasive techniques leads to the development of arthroscopically-assisted or all-arthroscopic procedures. In 1987 Hawkins proposed an arthroscopic stapling of the talus tensioning the scared tissue of the ATFL remnant, but due to unsatisfactory results, the technique was abandoned. In the early 2000s, thermal shrinkage with radiofrequency retracting the scared ATFL was presented with good results but only in the short term.44,45 In 2009, it was presented an arthroscopic-assisted Brostrom procedure by Corte-Real and Moreira46 with the placement of a bony anchor in the distal fibula through the anterolateral portal and needing an extra portal and a wound no longer than a centimetre to tie the first knot. The outcome of this kind of procedure was similar to the open Brostrom although with greater complications regarding the superficial peroneal nerve. Later, a modification of this technique was developed to avoid the neurologic risk, using an accessory anterolateral portal allowing retrieving of the suture from the medial to the lateral side of the superficial peroneal nerve, avoiding this way its entrapment. To avoid percutaneous steps and their inherent risks, the all-inside arthroscopic technique was later developed and in 2013 by Vega et al.37 introducing the procedure with knotless suture anchor placed in the distal fibula tying the superior fascicule of the ATFL, and then it was added the biological augmentation using the inferior extensor retinaculum by Cordier et al.48 In 2019 another paper was published about all-inside technique enhancing the previous procedure targeting also the inferior fascicule of the ATFL and CFL, what was a big change in the technique as being able to address these two extra-articular structures from an intra-articular point of view.23 Before proceed to any gesture to the ATFL, the surgeon should assess its quality and subjectively categorise it as poor, moderate or excellent49 in order to decide between a repair or reconstruction procedure. For biomechanical reasons, anatomic repair techniques are preferred over reconstruction procedures.1,9,10,16,23 The native histological characteristics of the injured ligament can only be maintained
through its repair and these include the nerve receptors responsible for proprioception. If after arthroscopic assessment of ATFL, the ligament is considered to be of poor quality, which can happen in 20–41% of patients elected to surgery due to lateral ankle instability, reconstruction with allograft or autograft should be considered. In cases of ligament reconstruction, autologous Gracilis tendon graft seems to be the most consensual graft in the literature due to its biomechanical properties and easy access. However, high cost and immunogenic response associated with allograft use are still a matter of concern, and autograft harvesting can be difficult and cause donor site morbidity. Therefore, techniques that sacrifice a tendon should be reserved for salvage procedures in patients with a failed ligament repair or with long-standing ligamentous insufficiency and absence of ligament remnant.

The all-inside arthroscopic ATFL repair augmentation using non-absorbable sutures offers the benefit of maintaining the native ligament while reinforcing the repair, especially in patients with poor remnant ligament-tissue quality that otherwise would necessitate a reconstruction technique. In addition, augmenting the ligament repair with high-resistance sutures allows early rehabilitation without the need of extended protection. Other potential indications of this technique would include ankle instability with excellent or moderate quality ligament remnant and high demanding patient activity, contra-indications of prolonged ankle immobilisation or patients in need of faster postoperative ankle mobilisation.

In cases of microinstability, mimicking the open procedure described by Järvelä et al. in 2002, Vega et al. performed a cadaveric study proposing an arthroscopic transfer of the tibial origin of the ATFL’s distal fascicle onto the talar insertion of ATFL superior fascicle. This study proved that this all-arthroscopic procedure is safe and reliable.

Regarding RAI, Buchhorn et al. proposed an open repair of both lateral and medial structures after a diagnostic arthroscopy. Vega et al. described an ‘all-inside’ technique for the same pathology using a knotless suture anchor addressing both the lateral complex and the anterior deep fascicle of the deltoid ligament. In both studies, excellent clinical and radiographic outcomes were achieved. It is difficult to ascertain if patients would have had similar outcomes if they were treated only for the lateral ligamentous injury. It was from the authors’ experience that some patients treated with isolated lateral ligamentous repair developed postoperative medial ankle symptoms and residual pain. It was only in recognising the rotational instability injury pattern could we identify those patients who might have benefited from an additional deltoid repair. A cautious look for deltoid ligamentous injury is advised in every patient undergoing arthroscopic ankle ligamentous repair and the authors believe that any identified injury must be anatomically treated to allow for the best results.

**Chronic medial instability**

Because chronic medial instability often does not cause severe disability that cannot be treated conservatively and because the reconstructive options have had less success than those laterally, there is little information concerning the best treatment options for this difficult problem. The treatment options depend on the level of ligament injury and local soft tissue status (Table 2). The primary option is to tension the deltoid from distal to proximal and attach it to the medial malleolus by transosseous sutures or anchors, provided that the deltoid tissue quality is sufficient. If the soft tissues are inadequate for a stable direct repair, reconstruction options are the alternative.

**Reconstruction of type I lesion (most common):** The anterior border of the medial malleolus is exposed and refreshed to create a rough surface suitable for ligament reattachment. Two drill holes are made in the medial malleolus at 5–6 mm from the tip. Two intraosseous sutures (Vicryl 2) are inserted; the first is to shorten the tibionavicular and tibiospring fibres and the second is to shorten the anterior part of the deep deltoid ligament. These sutures should be tightened at 90° of ankle dorsiflexion. If the repair and ligaments remnants are weak, a periosteal flap is reflected from the medial aspect of the tibia to reinforce the repaired ligaments. Reconstruction of type II lesion: The degenerative and insufficient ligament tear is refreshed and debrided. End-to-end sutures are applied to the torn ligament. When there is a large gap, intraosseous sutures to the medial malleolus should be added. Additional soft tissue and a periosteal flap may be needed to augment the repaired ligament. Reconstruction of type III lesion: The tear is debrided. Then two Vicryl sutures are inserted into the spring ligament side by side. A periosteal flap is added to the repair in cases of insufficient soft tissue remnants. In patients where ankle instability persists, and ligament quality is insufficient, direct reconstruction with anchors may not be possible. In these cases, autologous reconstruction using a free tendon graft is the surgical treatment of choice. The graft is passed through two drill holes of 3.2 mm at 2–8 mm above the medial malleolar tip and through another dorsoplantar drill hole in the navicular bone. Holding the foot in a neutral position, the graft is fixed with resorbable sutures under slight tension. Attention needs to be paid to reconstruct the tendon in a

**Table 2. Types of medial-sided ankle sprains.**

| Type I (most common) | Type II | Type III |
|----------------------|---------|----------|
| Mild tear or avulsions of the tibionavicular or tibiospring ligaments | Intermediate tears of the same ligaments | Distal, more severe tears of the tibionavicular and spring ligaments |

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strict anatomic position and to not overtighten the ligament construct.  

Reconstruction of the affected ligaments alone has been successful in inherently well-aligned feet; however, this is not the same in cases with longstanding hindfoot valgus and forefoot abduction. With these deformities, the achieved ligament repair tends to fail once the patients resume full physical and sports activity. These cases require either a lateral calcaneal lengthening OT or a medial sliding calcaneal OT to correct hindfoot valgus and forefoot abduction or hindfoot valgus only, respectively.  

Conclusion
Ankle instability is an underdiagnosed but still very prevalent pathology. Understanding the anatomy and the biomechanics of the ankle is essential for both diagnosis and treatment. Non-surgical treatment is indicated for all cases, both acute and chronic, as the first line of treatment, leaving surgery for refractory cases or selected cases like professional athletes.

Nowadays, although diagnostic arthroscopy is considered mandatory, the open Brostrom-Gould procedure is still considered the gold standard of treatment of lateral ankle instability. On the other hand, with the existing trend for minimally invasive surgery and the development of newer devices, arthroscopic-assisted or all-arthroscopic procedures are expected to increase as well as procedures addressing the deltoid ligament.

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References
1. Waterman BR, Owens BD, Davey S, et al. The epidemiology of ankle sprains in the United States. J Bone Joint Surg Am 2010; 92: 2279–2284.
2. Canale ST, Beatty JH and Campbell WC. Campbell’s Operative Orthopaedics. Philadelphia, PA: Mosby/Elsevier, 2013.
3. Stormont DM, Morrey BF, and An KN. Stability of the loaded ankle. Relation between articular restraint and primary and secondary static restraints. Am J Sports Med 1985; 13: 295–300.
4. Berkowitz MJ and Kim DH. Fibular position in relation to lateral ankle instability. Foot Ankle Int 2004; 25: 318–321.
5. Amado P. Avaliação morfométrica do maléolo interno e relação com a instabilidade do externo do tornozelo. 1998.
6. Neuschwander TB, Indresano AA, Hughes TH, et al. Footprint of the lateral ligament complex of the ankle. Foot Ankle Int 2013; 34: 582–586.
7. Vega J, Malagelada F, Manzanares Céspedes M-C, et al. The lateral fibulotalocalcaneal ligament complex: an ankle stabilizing isometric structure. Knee Surg Sports Traumatol Arthrosc 2020; 28: 8–17.
8. Pieter d’Hooghe EG and Longo U. Torn ankle ligaments in elite handball: does a player require surgery? Aspetar Sports Med J 2014; 30: 186–194.
9. Hintermann B, Boss A and Schäfer D. Arthroscopic findings in patients with chronic ankle instability. Am J Sports Med 2002; 30: 402–409.
10. Vega J, Allmendinger J, Malagelada F, et al. Combined arthroscopic all-inside repair of lateral and medial ankle ligaments is an effective treatment for rotational ankle instability. Knee Surg Sports Traumatol Arthrosc 2020; 28: 132–140.
11. Vega J, Peña F and Golano P. Minor or occult ankle instability as a cause of anterolateral pain after ankle sprain. Knee Surg Sports Traumatol Arthrosc 2016; 24: 1116–1123.
12. Bonnel F, Toullec E, Mabit C, et al. Chronic ankle instability: biomechanics and pathomechanics of ligaments injury and associated lesions. Ortop Traumatol Surg Res 2010; 96: 424–432.
13. McKeon PO and Hertel J. Systematic review of postural control and lateral ankle instability, part II: is balance training clinically effective? J Athl Train 2008; 43: 305–315.
14. Vega J, Guelfi M, Heyrani N, et al. Ankle microinstability. Tech Foot Ankle Surg [Internet]. 2019; 18. https://journals.lww.com/techfootankle/Fulltext/2019/06000/Ankle_Microinstability6.aspx
15. Frey C, Bell J, Teresi L, et al. A comparison of MRI and clinical examination of acute lateral ankle sprains. Foot Ankle Int 1996; 17: 533–537.
16. van Dijk CN, Lim LS, Bossuyt PM, et al. Physical examination is sufficient for the diagnosis of sprained ankles. J Bone Joint Surg Br 1996; 78: 958–962.
17. Michels F, Pereira H, Calder J, et al. Searching for consensus in the approach to patients with chronic lateral ankle instability: ask the expert. Knee Surg Sports Traumatol Arthosc 2018; 26: 2095–2102.
18. Tourné Y, Besse J-L and Mabit C. Chronic ankle instability. Which tests to assess the lesions? Which therapeutic options? Orthrop Traumatol Surg Res 2010; 96: 433–446.
19. Morvan A, Klouche S, Thes A, et al. Reliability and validity of preoperative MRI for surgical decision making in chronic lateral ankle instability. Eur J Orthop Surg Traumatol 2018; 28: 713–719.
20. Park JW, Lee SJ, Choo HJ, et al. Ultrasonography of the ankle joint. Ultrason (Seoul, Korea) [Internet]. 2017/04/05. 2017; 36: 321–335. https://pubmed.ncbi.nlm.nih.gov/28535605
21. Alshalawi S, Galhoum AE, Alrashidi Y, et al. Medial ankle instability: the deltoid dilemma. Foot Ankle Clin 2018; 23: 639–657.
22. Okuda R, Kinoshita M, Morikawa J, et al. Arthroscopic findings in chronic lateral ankle instability: do focal chondral lesions influence the results of ligament reconstruction? *Am J Sports Med* 2005; 33: 35–42.

23. Vega J, Malagelada F and Dalmau-Pastor M. Arthroscopic all-inside ATFL and CFL repair is feasible and provides excellent results in patients with chronic ankle instability. *Knee Surg Sports Traumatol Arthrosoc* 2020; 28: 116–123.

24. Pereira H, Vuurberg G, Spennacchio P, et al. Surgical treatment paradigms of ankle lateral instability, osteochondral defects and impingement. *Adv Exp Med Biol* 2018; 1059: 85–108.

25. Camacho LD, Roward ZT, Deng Y, et al. Surgical management of lateral ankle instability in athletes. *J Athl Train* 2019; 54: 639–649.

26. White WJ, McCollum GA and Calder JDF. Return to sport following acute lateral ligament repair of the ankle in professional athletes. *Knee Surg Sports Traumatol Arthrosoc* 2016; 24: 1124–1129.

27. Vuurberg G, Hoornje A, Wink LM, et al. Diagnosis, treatment and prevention of ankle sprains: update of an evidence-based clinical guideline. *Br J Sports Med* 2018; 52: 956.

28. Doherty C, Bleakley C, Delahunt E, et al. Treatment and prevention of acute and recurrent ankle sprain: an overview of systematic reviews with meta-analysis. *Br J Sports Med* 2017;51:113–125.

29. Vuurberg G, Veen OC, Pereira H, et al. Tenodesis reconstruction in patients with chronic lateral ankle instability is associated with a high risk of complications compared with anatomic repair and reconstruction: a systematic review and meta-analysis. *J Isakos Jt Disord & Orthop Sports Med [Internet]*. 2017; 2: 81 LP – 88. http://jisakos.bmj.com/content/2/2/81.abstract

30. Hunt KJ, Pereira H, Kelley J, et al. The role of Calcaneofibular ligament injury in ankle instability: implications for surgical management. *Am J Sports Med* 2019; 47: 431–437.

31. Lee KT, Park YU, Kim JS, et al. Long-term results after modified Broström procedure without calcaneofibular ligament reconstruction. *Foot Ankle Int* 2011; 32: 153–157.

32. Broström L. Sprained ankles. VI. Surgical treatment of “chronic” ligament ruptures. *Acta Chir Scand* 1966; 132: 551–565.

33. Gould N, Seligson D and Gassman J. Early and late repair of lateral ligament of the ankle. *Foot Ankle* 1980; 1: 84–89.

34. Karlsson J, Bergsten T, Lansinger O, et al. Surgical treatment of chronic lateral instability of the ankle joint. A new procedure. *Am J Sports Med* 1989; 17: 264–268.

35. Cho B-K, Park K-J, Kim S-W, et al. Minimal invasive suture-tape augmentation for chronic ankle instability. *Foot Ankle Int* 2015; 36: 1330–1338.

36. Cho B-K, Hong S-H and Jeon J-H. Effect of lateral ligament augmentation using suture-tape on functional ankle instability. *Foot Ankle Int* 2019; 40: 447–456.

37. Cho B-K, Park J-K, Choi S-M, et al. A randomized comparison between lateral ligaments augmentation using suture-tape and modified Broström repair in young female patients with chronic ankle instability. *Foot Ankle Surg Off J Eur Soc Foot Ankle Surg* 2019; 25: 137–142.

38. Xu J, Peng L and Lu W. Letter to the editor on “A randomized comparison between lateral ligaments augmentation using suture-tape and modified Broström repair in young female patients with chronic ankle instability”. *Foot Ankle Surg: Off J Eur Soc Foot and Ankle Surg* 2018; 24: 555.

39. Ko KR, Lee W-Y, Lee H, et al. Repair of only anterior talofibular ligament resulted in similar outcomes to those of repair of both anterior talofibular and calcaneofibular ligaments. *Knee Surg Sports Traumatol Arthrosoc* 2020; 28: 155–162.

40. Maffulli N, Del Buono A, Maffulli GD, et al. Isolated anterior talofibular ligament Broström repair for chronic lateral ankle instability: 9-year follow-up. *Am J Sports Med* 2013; 41: 858–864.

41. Lewis TL, Joseph A, Patel A, et al. Modified Broström repair with suture tape augmentation for lateral ankle instability: a systematic review. *Foot Ankle Surg Off J Eur Soc Foot Ankle Surg* 2021; 27: 278–284.

42. Lei T, Qian H, Lei P, et al. Lateral augmentation reconstruction system versus modified Brostrom-Gould procedure: a meta-analysis of RCTs. *Foot Ankle Surg Off J Eur Soc Foot Ankle Surg* 2021; 27: 263–270.

43. Broström L. Sprained ankles. V. Treatment and prognosis in recent ligament ruptures. *Acta Chir Scand* 1966; 132: 537–550.

44. Espregueira-Mendes J and Amado P. Paper #87 chronic ankle instability: results with arthroscopic shrinkage with thermal retraction. *Arthrosc J Arthrosoc Relat Surg—Arthrosc* 2003; 19: 44.

45. Oloff LM, Bocko AP and Fanton G. Arthroscopic monopolar radiofrequency thermal stabilization for chronic lateral ankle instability: a preliminary report on 10 cases. *J Foot Ankle Surg Off Publ Am Coll Foot Ankle Surg* 2000; 39: 144–153.

46. Corte-Real NM and Moreira RM. Arthroscopic repair of chronic lateral ankle instability. *Foot Ankle Int* 2009; 30: 213–217.

47. Vega J, Golanó P, Pellegrino A, et al. All-inside arthroscopic lateral collateral ligament repair for ankle instability with a knotless suture anchor technique. *Foot Ankle Int* 2013; 34: 1701–1709.

48. Cordier G, Lebecque J, Vega J, et al. Arthroscopic ankle lateral ligament repair with biological augmentation gives excellent results in case of chronic ankle instability. *Knee Surg Sports Traumatol Arthrosoc* 2020; 28: 108–115.

49. Vega J, Montesinos E, Malagelada F, et al. Arthroscopic all-inside anterior talo-fibular ligament repair with suture augmentation gives excellent results in case of poor ligament tissue remnant quality. *Knee Surg Sports Traumatol Arthrosoc* 2020; 28: 100–107.

50. Vega J, Poggio D, Heyrani N, et al. Arthroscopic all-inside ATFL’s distal fascicle transfer for ATFL’s superior fascicle...
reconstruction or biological augmentation of lateral ligament repair. *Knee Surg Sports Traumatol Arthrosc* 2020; 28: 70–78.

51. Lopes R, Andreu M, Cordier G, et al. Arthroscopic treatment of chronic ankle instability: prospective study of outcomes in 286 patients. *Orthop Traumatol Surg Res* 2018; 104: S199–S205.

52. Teixeira J and Guillo S. Arthroscopic treatment of ankle instability—allograft/autograft reconstruction. *Foot Ankle Clin* 2018; 23: 571–579.

53. Coetzee JC, Ellington JK, Ronan JA, et al. Functional results of open Broström ankle ligament repair augmented with a suture tape. *Foot Ankle Int* 2018; 39: 304–310.

54. Yoo J-S and Yang E-A. Clinical results of an arthroscopic modified Brostrom operation with and without an internal brace. *J Orthop Traumatol Off J Ital Soc Orthop Traumatol* 2016; 17: 353–360.

55. Järvelä T, Weitz H, Järvelä K, et al. A novel reconstruction technique for chronic lateral ankle instability: comparison to primary repair. *Int Orthop* 2002; 26: 314–317.

56. Buchhorn T, Sabeti-Aschraf M, Dlaska CE, et al. Combined medial and lateral anatomic ligament reconstruction for chronic rotational instability of the ankle. *Foot Ankle Int* 2011; 32: 1122–1126.

57. Knupp M, Lang TH, Zwicky L, et al. Chronic ankle instability (medial and lateral). *Clin Sports Med* 2015; 34: 679–688.