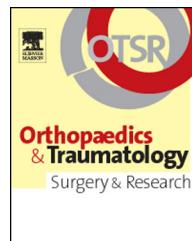




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REVIEW ARTICLE

Consensus in chronic ankle instability: Aetiology, assessment, surgical indications and place for arthroscopy

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Summary Ankle sprains are the most common injuries sustained during sports activities. Most ankle sprains recover fully with non-operative treatment but 20–30% develop chronic ankle instability. Predicting which patients who sustain an ankle sprain will develop instability is difficult. This paper summarises a consensus on identifying which patients may require surgery, the optimal surgical intervention along with treatment of concomitant pathology given the evidence available today. It also discusses the role of arthroscopic treatment and the anatomical basis for individual procedures.

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Aetiology of chronic ankle instability

The main predisposing factor for the development of chronic ankle instability (CAI) is the history of at least one previous lateral ankle sprain [1–3]. There is no correlation between the severity of the initial sprain as judged at the time of injury and the frequency of residual instability [2]. The risk of developing CAI is as great after a single severe ankle sprain as after one or multiple minor sprains. Thus, there are other factors contributing to the development of CAI.

It is estimated that as many as 55% of patients who sustain an ankle sprain do not seek evaluation or treatment from a healthcare professional [4]. The absence of treatment after an ankle sprain predisposes to residual symptoms including CAI [5]. With respect to giving-way and return to sport, improved stability with faster recovery was noted after surgical treatment for acute ankle sprain compared to non-operative treatment. However, the advantages of this operative treatment should be balanced with the risk of complications and the costs [6–8]. Functional treatment after acute ankle sprain (with early proprioceptive rehabilitation) enables better results and faster recovery compared to immobilization [9–12]. However, there are still controversies concerning the exact role of rehabilitation on the prevention of ankle sprain recurrence [13].

Mechanical instability is due to the laxity caused by ligaments tears. Functional instability is due to proprioceptive and muscular deficits after ankle sprain [14,15]. Both mechanical and functional instabilities may be difficult to assess or distinguish and they most often occur as a combination in the development of CAI.

The level of activity is a very important extrinsic factor influencing the impact of CAI in the daily life. The assessment of activity level for each patient is useful not only to differentiate patients at high or low risk of developing CAI after an ankle sprain, but also to find the optimal treatment and also allows comparison of functional results. Different factors such as level of sport activities (professional, amateur competitive, leisure, sedentary), type of sport, work and shoes must be assessed when questioning the patient. It has recently been suggested that there may be a role for those early operative repair of the ligaments in the acute stage in elite athletes with a severe ankle sprain and significant ankle instability as this is known to reduce the risk of CAI as the incidence of significant symptoms following non-operative management is approximately 20% [16].

Lower limb varus mal-alignment has been described as an important factor predisposing to ankle sprain and CAI [17]. Anatomical variations of the tibiotalar joint such as axis of rotation, talar dome radius or retroposition of the lateral malleolus can predispose to ankle sprain and CAI [17–20].

Pathological conditions of the tibiotalar joint such as limitation of dorsiflexion (anterior impingement, short gastrocnemius), chondral problems (ankle osteochondral defects, loose bodies) or bimalleolar diastasis can provoke or increase CAI [21].

Subtalar joint anatomical variations (axis of rotation, hindfoot varus) or pathologies (talocalcaneal coalition, subtalar joint laxity due to injuries of the cervical ligament, the talocalcaneal ligament or the interosseous ligament) act as risk factors of CAI [22–27]. Anatomical and

histological variations of the collateral lateral ligament (insertion zones, number of bands, collagen diseases) are also important intrinsic risk factors for CAI [20,28–30]. Peroneal tendons pathologies can provoke or increase a CAI [31] and pathologies with a proprioceptive deficit or imbalance in neuromuscular control are a frequent cause of CAI [17,32].

Evidence from peer-reviewed literature suggests that the characteristics of patients who develop chronic ankle instability are not homogeneous. The aetiological elements of CAI are a continuum of pathologic conditions and anatomic variability. A good knowledge of these characteristics will improve the decisions for the treatment.

Not all aetiological aspects are yet defined and more studies are needed. A well-known pathological condition is the patient with persisting complaints of instability associated with pain, but without any objective characteristics. This may be explained by formation of scar tissue and arthroscopic approach may be useful to assess the ankle joint in these situations [33].

Clinical assessment of chronic ankle instability

History of an ankle sprain must precede the symptoms of CAI. A lateral ankle sprain is defined as an episode of acute inversion/supination injury of the ankle associated with swelling, lateral ankle pain and difficulty weight-bearing. Chronic ankle instability is defined as the perception by the patient of an abnormal ankle with a combination of symptoms including recurrent sprains, pain and swelling or avoidance of activities.

The following standard questions should be asked of patients with ankle instability:

- how long ago was the first acute event?
- what were the modalities of treatment?
- does the ankle continue to give way? (yes or no):
 - if yes, with what frequency?
- is there an adaptation or avoidance to daily or sport activities? (yes or no);
- is there an ankle pain between new sprain events? (yes or no):
 - if yes, the location of the pain must be defined;
- does the ankle swell? (yes or no):
 - if yes, the location of the swelling must be specified.

The purpose of these questions is to establish which of the following five presentations is present all of which are compatible with CAI:

- recurrent acute ankle sprain;
- giving way of the ankle without new sprain;
- perception of an insecure/unstable ankle by the patient;
- avoidance of/adaptation to daily or sporting activities;
- perception of an abnormal ankle by the patient (pain, swelling).

The physical examination must include comparative assessment of both ankles. Lower leg and hindfoot alignment must be assessed whilst standing and gait should be evaluated. Precise location of tenderness must be identified. Active and passive ankle range of motion (ROM)

is measured with the knee extended and then on a sitting position with the legs down and the knees flexed to 90° in order to assess gastrocnemius tightness. Hindfoot inversion/eversion is compared to the other side. In view of the difficulty in making precise measurements of hindfoot mobility, grading as normal, abnormal (increased or decreased) or no mobility is appropriate. An assessment of generalised joint laxity is important (Beighton scale). Strength and pain on resisted function of peroneal and tibialis posterior tendons are specifically tested and neurovascular status of the lower legs is then assessed. Ankle ligament testing is comparative and performed on a relaxed patient in a sitting position with the knee flexed. It may be difficult to describe the degree of ankle laxity of the anterior drawer test between examiners and therefore a simple description of stable, unstable, unstable with sulcus sign may be preferred. The presence of varus tilt is frequently difficult to assess and laxity or absence of laxity compared to the other side is likewise preferred [34,35]. Stability and proprioceptive control of the ankle can be assessed by the patient standing with a single leg stance (eyes open and then eyes closed). This test may be helpful to differentiate mechanical from functional instability [36,37].

Radiographic assessment

The standard plain radiographs include: standing antero-posterior, lateral and mortise views and a comparative Saltzmann view (or Méary view), which is helpful to assess hindfoot alignment. Comparative stress radiographic views with anterior drawer test and varus tilt may be performed although it should be recognised that these have a high rate of false negative results [34,35].

Magnetic resonance imaging may be helpful in the presence of deep pain to assess for osteochondral lesions and tendon injuries and it will also confirm the presence of chronic ligamentous injury. Ultrasonography may be particularly helpful in the assessment of tendon pathology. Computer tomography/MRI-arthrogram scanning is not routinely advised but may be helpful for accurate assessment of chondral lesion.

Scoring systems for chronic ankle instability

Quantifying the severity of ankle instability is a difficult problem. Many patients may not have any episodes of actual giving way or falling, as they tend to avoid aggravating situations. Instead, the main complaint is often just a feeling of vulnerability and this is hard to measure objectively. However, an attempt has to be made to gauge the severity of the problem in order to facilitate decisions regarding indications for surgery, return to sport and of course assessing the quality of the outcome of surgical intervention.

The history of outcome scoring for instability mirrors the experience of orthopaedics as a whole, moving from surgeon-designed and -administered scores to more objective patient-centred measures (Table 1). We are fortunate that in this area we have some objective measures (Table 2) that can be used to analyse the clinimetric properties of the various outcome scores though they are not appropriate for everyday clinical use.

Table 1 Outcome scores.

Generic health scores	Disease specific scores
SF12 [38]	Karlsson 1988 [44] Kaikkonen 1994 [45]
EuroQoL -EQ5D [39]	Ankle joint functional assessment tool (AJFAT) 1999 [46]
Generic foot and ankle scores	Functional Ankle Disability Index (FADI) Functional Ankle Disability Sport (FADI-Sport) 1999 [47]
American orthopaedic foot and ankle score (AOFAS) [40]	Sports ankle rating system (SARS) 2003 [48]
Foot and ankle outcome score (FAOS) 2001 [41]	Foot and ankle assessment measure (FAAM) 2005 [49]
Activity assessment scales	Ankle instability index (AII) 2006 [50]
Tegner 1985 [42]	Cumberland Ankle Instability Tool (CAIT) 2006 [51]
Halasi 2004 [43]	Foot and ankle instability questionnaire (FAIQ) 2007 [52]
	Chronic ankle instability scale (CAIS) 2008 [53]
	Identification of foot and ankle instability (IdFAI) 2011 [54]

To-date, there has been no consensus on the best score to use. A variety of instruments have been advocated, many of which are not validated or even appropriate for instability (Table 3). A number of studies have analysed many of these scores, though none have as yet proved to be clearly superior [64–66]. The IdFAI score is the most recent and promising score but it is yet to be used in any published studies [54]. The authors themselves feel that it is a starting point for further development and refinement rather than a definitive measure.

Consensus was reached that this area needed much more work but that comparison of results required a standardised approach. The FAOS score was selected as this has been validated for use in ankle ligament reconstruction, it is patient-centred and easy to complete [41]. This should be

Table 2 Physical tests.

Non-instrumented	Instrumented
Single leg balance [36,37]	Force platforms- static and dynamic testing [58]
Hopping tests – on-the-spot, lateral, figure-of-8 [55]	Surface EMG- peroneal reaction times [59]
Y balance test and star excursion balance test [56]	
Balance error scoring system [57]	

Table 3 Review of instability literature from foot and ankle instability 2012 to present.

Study	Outcome score used
Tourné et al. 2012 [60]	Karlsson
Youn et al. 2012 [61]	Good Jones
Miller et al. 2013 [62]	Livingstone
Vega et al. 2013 [63]	Karlsson
	FAAM
	AOFAS

used in conjunction with the EQ5D, a 5-item generic health measure that is similarly quick and easy to complete.

There is a wide variation in the type of patient from the office worker to the 'week-end warrior' and the elite athlete. Therefore it is recommended that the Halasi activity level score, a modernised version of the Tegner Score, is used to define the patient population of individual series' in order to inform comparison of outcome in light of demand and expectation [42,43].

Arthroscopic assessment in chronic ankle instability

A review of the literature shows that 13 to 35% of patients report symptoms such as pain and recurrent instability after a successful ligament reconstruction [67–71]. Intra-articular pathology has been suggested as the cause for these persistent symptoms, and although many authors have reported arthroscopic findings in patients with chronic lateral ankle instability, there has been no attempt to correlate the type and number of intra-articular lesions with the patient outcome.

Previous studies stated that osteochondral lesions of the talus, soft tissue impingement lesions, osseous loose bodies, peroneal tendon disorders and other associated injuries could be sources of postoperative pain in chronic ankle instability patients [20,71–75]. To date, there have been few reports on surgical results with regard to intra-articular lesions in patients with chronic lateral ankle instability. Choi et al. have shown that 63 out of 65 cases of ankle instability (96.9%) had intra-articular lesions, of which 53 cases (81.5%) showed soft tissue impingement as the most common associated lesion [21]. Other associated intra-articular lesions included ossicles at the lateral malleolus (38.5%), syndesmosis widening (29.2%), and osteochondral lesion of the talus (23.1%). One of the notable features of this study is that they have analyzed the clinical outcome relative to the presence of intra-articular lesions and have shown that the strongest risk indicators for patients' dissatisfaction were syndesmosis widening, osteochondral lesions of the talus and ossicles. The number and severity of lesions was greater in those with chronic instability and this was also associated with a poor clinical outcome following surgery.

The high rate of soft tissue impingement in chronic ankle instability may be a response to a coexisting intra-articular lesion or repetitive inversion stress to the ankle. The term "soft tissue impingement" included hypertrophic synovial

and fibrotic scar tissue obliterating the joint space that corresponded to localized tenderness. Soft tissue impingement is known to be strongly associated with osteochondral lesions due to the self-regeneration mechanism of synovial osteoprogenitor cells that migrate to the lesion site. However, there is disagreement about whether this would affect the clinical outcome [76–78]. Lee et al. described the diagnosis and arthroscopic treatment of soft tissue impingement in 38 patients with chronic ankle pain after trauma [79].

Ossicles at the tip of the lateral malleolus are frequently found in patients with chronic lateral ankle instability. However, the relationship between the presence or the size of an ossicle and the outcome of ligament reconstruction is poorly understood. Kim et al. reported that ankles with large ossicles improved post-reconstruction with regards to varus stability but not anteroposterior stability [80]. When the ossicle is large, excision and the modified Broström technique may not be suitable to achieve mechanical anteroposterior stability. Therefore, fusing the ossicle to the fibular tip or using other methods of ligament reconstruction may need to be considered in chronic ankle instability with associated large ossicles (Fig. 1).

Syndesmosis widening has been recognized as one of the causes of prolonged ankle pain. Injury to the syndesmotic ligaments occurs as a result of external rotation forces, which often accompany inversion sprains. Syndesmotic instability was defined as the ability to displace the fibula laterally more than 2 mm with the shoulder of the probe while placed in the syndesmotic joint [81–84]. This criterion was based on the study by Close who reported that the maximum widening of the intra-articular distal tibiofibular syndesmosis was approximately 1.5 mm in a normal ankle [85]. Teramoto and Taylor reported that a possible explanation for the increased incidence of recurrent sprains in patients with syndesmosis widening is altered fibular mobility leading to altered ankle biomechanics [86,87]. Disrupted distal fibular migration and fibular axial motion can alter normal ankle function. The resultant alteration in ankle function may predispose the ankle to inversion sprains. Therefore, after the distal tibiofibular syndesmosis is ruptured, healing is protracted, functional disability is not uncommon and prognosis is guarded. Some controversy exists regarding the treatment method and the merits of screw fixation [82,88,89]. Han et al. in accordance with Ogilvie-Harris and Reed suggested that soft tissue hypertrophy and its subsequent impingement may be the cause of pain and disability in chronic tibiofibular syndesmosis injury [81,82]. They recommended arthroscopic marginal resection alone if it has been determined that there is no rupture of the medial deltoid ligament and, thus, no effect on the contact surface and maximal pressure of the ankle joint. Poor functional outcome from residual instability of the distal tibiofibular joint may occur after lateral ligament reconstruction and anatomical reconstruction of syndesmosis will be needed to restore syndesmosis stability.

Several studies have shown that chronic lateral ankle instability is often associated with chondral lesions in the ankle [73–75,90]. It is clear that high contact pressure and shear stress adjacent to cartilage defects may interfere with hyaline cartilage function in adjacent areas of normal cartilage [91,92]. Such a deleterious effect may explain the worse clinical outcome with osteochondral lesions in spite

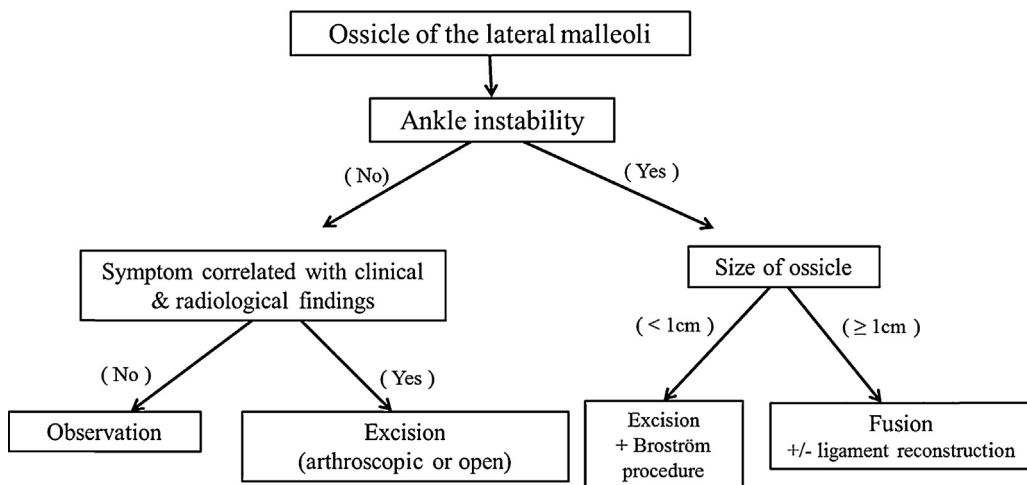


Figure 1 Treatment algorithm of an ossicle of the lateral malleoli in patients with chronic ankle instability.

of a successful ligament reconstruction. Few investigators have reported on the differences in the clinical outcomes of arthroscopic treatment for osteochondral lesions performed on lateral ligament reconstructed ankles *versus* arthroscopy done in isolated osteochondral lesions in lateral ligament-intact ankles.

There have been no clear criteria to help surgeons decide whether the ligament remnant will be sufficient for Brostrom-type procedures. Judgment of this has historically been unscientific, merely relying on the surgeon's experience. Normal ligaments consist of 90% type 1 collagen, which is primarily responsible for the stiffness and strength of the ligament [93–95]. Any decrease of type 1 collagen suggests the strength of the ligament is weaker than the normal. Yasui and Takao compared the arthroscopic and histological findings of the ATFL remnant, and clarified the degree of irregularity of ATFL fibre in arthroscopic assessment. If the ATFL had a highly irregular appearance in arthroscopic evaluation, histology showed that the ligament fibres consisted of scar tissue without type I collagen [96]. There was good correlation between the arthroscopic assessment of irregularity of the ATFL remnant and the histological appearance. They therefore recommended that the surgical procedure should be selected according to the arthroscopic assessment of the ATFL remnant (Fig. 2).

Therefore, a thorough arthroscopic assessment is indicated prior to lateral ligament reconstruction in addition to clinical and radiological examination, unless a patient is pain-free with negative radiological assessment. This assessment should include careful inspection for any soft tissue impingement, syndesmosis widening, osteochondral lesions as well as the appearance of the remnant of the ATFL in order to determine the correct surgical strategy.

Surgical indications for chronic ankle instability

Over the past 40 years, the orthopaedic community has witnessed an evolution in knee and shoulder surgery for unstable joints from non-anatomic reconstructions utilizing open approaches toward anatomical reconstructive procedures performed either through smaller open incisions or arthroscopically. The surgical treatment of chronic lateral ankle instability is currently evolving in a similar manner. Traditional open procedures to stabilize the ankle using tendon grafts placed non-anatomically can result in a stable ankle. However, these procedures, such as the Chrisman-Snook, Evans, and Watson-Jones, may over-constrain both the ankle and subtalar joints resulting in limitation of joint motion and long term development of degenerative arthritis. Contemporary techniques emphasize anatomic repair/reconstruction to restore stability while attempting to minimize these complications.

For the purposes of this article, we define repair as the primary or secondary suturing of the torn lateral ligaments. A reconstruction refers to the replacement of the chronically deficient lateral ligaments with local tissues or with autograft or allograft tissue.

Local ligament soft tissue repair techniques

The classic Broström procedure is a true repair of the lateral ligaments including the ATFL and the CFL. However, it is rarely performed as a stand-alone procedure. Since it is usually augmented with a transfer of the extensor retinaculum

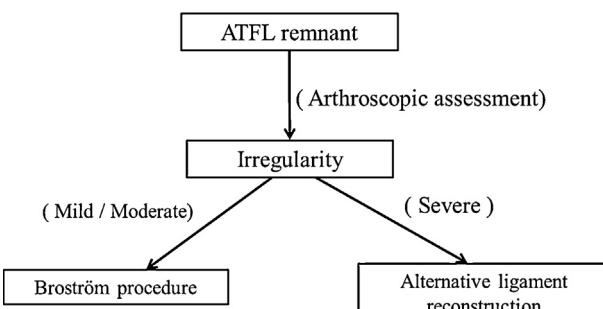


Figure 2 Selection of the surgical procedure according to arthroscopic evaluation of the remnant of the anterior talofibular ligament (ATFL).

either as a proximal advancement (Gould procedure) or as a pedicle flap of retinaculum, we classify this procedure as a repair/augmentation. There is question as to whether the extensor retinaculum truly provides mechanical ankle and subtalar stability through its attachment to the calcaneus or if it simply provides for an enhanced proprioceptive environment. No matter the method of effectiveness, the retinacular augmentation is regarded as a critical element of this procedure's success. The procedure may be performed the traditional manner with drill holes or bone anchors with attached nonabsorbable suture may be utilized. It is the consensus of the ankle instability group that this procedure is the appropriate first-line consideration for patients with chronic lateral ankle ligament laxity requiring surgical treatment.

Ligament reconstruction using tendon graft or transfer

Anatomic reconstruction with tendon graft or transfer

Traditionally these types of procedures have been reserved for patients who have failed a prior Broström-Gould repair. However, patients who may stress their ankle to a greater degree than normal, including those with high body mass index, heavy labor occupation or sports requirements, or patients with congenital ligament laxity may benefit from performing ligament reconstruction as the primary procedure. Although isometry of the lateral ankle ligaments has not been proven, placement of the tendon grafts at the ligaments' anatomical origin and insertion should be performed. The goal is to achieve good ankle stability without overconstraining the ankle or subtalar joints. Non-anatomic positioning of the graft may alter the biomechanics of the joints resulting in joint loading alterations which may lead to joint degeneration over time.

These procedures have in common the routing of the transferred tendon graft in such a way as to replicate the anatomic positions of the ATFL and CFL origin and insertion sites. They vary in the means by which they attain that positioning, including the number and angle of tunnels in the fibula and the fixation techniques selected in each bone tunnel location. There are many different ways the ligament graft can be secured in the bone including anchors, bone tunnels with interference screws, and endobutton type devices. The selected fixation device should be secure enough to maintain appropriate tension on the reconstruction intra-operatively as well as support healing and potentially allow for early joint motion. The surgeon may elect to use hamstring autograft or allograft depending on patient requirements and the resources and training available to the surgeon.

Non-anatomical reconstruction with tendon transfer or graft

Non-anatomic reconstructions of the lateral ankle ligaments have a long track record in the orthopaedic literature where they have been shown historically to work well to establish a stable hindfoot for functional activities. Similar to the non-anatomical instability procedures performed in the knee and shoulder, the long-term results in the ankle reveal an increased incidence of degenerative changes in the

hindfoot. Several of these procedures utilize a segment or the entire peroneal tendon as either a graft or transfer. The peroneal tendons are important dynamic stabilizers of the hindfoot and harvesting these tendons for grafts or transfers may result in long-term weakness and loss of dynamic stabilization of the ankle and subtalar joints. Our consensus is that with modern fixation techniques and the known long-term degenerative sequelae associated with non-anatomical reconstruction, these procedures should be avoided.

Arthroscopic lateral ligament procedures

Numerous articles describe a high incidence of intra-articular pathology when ankle arthroscopy is performed at the time of ligament reconstruction [21, 72–74, 82–84]. This finding has prompted many surgeons to recommend performing arthroscopy in association with a lateral ligament reconstruction [33, 83].

In the last five years there have been several arthroscopically assisted techniques to perform lateral ankle ligament reconstruction described in the orthopaedic literature [63, 97–104]. These techniques show early promising results in level IV studies with short-term follow-up. These procedures have in common the use of arthroscopic techniques to thoroughly clean out the lateral gutter to expose the anatomic origin of the lateral ligaments on the distal fibula followed by placement of one or more suture anchors into the fibula. There are various approaches to passing the sutures through the ATFL, CFL, and retinaculum to affect a repair/augmentation procedure, which effectively replicates the Broström-Gould procedure. The procedure may be further refined as specific instrumentation is devised to facilitate the repair/augmentation.

Techniques are also being developed to perform anatomic reconstructions using tendon graft using an all arthroscopic approach. These procedures are very technically demanding and they are early in their development. We believe that further investigation and reporting of results are required before these techniques can be adopted as routine. We recommend that before performing arthroscopic repair or reconstruction in the ankle, the surgeon should be highly skilled in arthroscopy of the ankle and should have gained experience on the procedures in cadaver workshops or with an experienced mentor.

The presence of a fibular ossicle can complicate performance of a lateral ligament reconstruction [21]. Recent studies indicate that an ossicle of less than 1 cm in greatest dimension can be safely excised and a local soft tissue reconstruction be performed. However, if the ossicle is more than 1 cm in any dimension, it is recommended that the surgeon either fuse the ossicle and proceed with a local soft tissue procedure; or excise the ossicle and proceed with an anatomic tendon graft/transfer type procedure.

Conclusion

Standardised assessment of the ankle pre-operatively and at follow-up is imperative in order to allow comparison of outcome from treatment with various techniques. The recording of clinical information along with standardised radiological evaluation as has been described above

following this consensus group meeting will help and the recommendations made here have been evaluated and are evidence-based. There is a move towards patient-orientated outcome scores which is why the ankle-specific validated systems have been advocated as they are relatively simple to use with less chance of information loss and increased chance patient compliance. The anatomical repairs are still the best methods of treatment in symptomatic chronic instability and with the high incidence of intra-articular pathology it is recommended that an arthroscopy is performed at the time of surgery unless intra-articular pathology has been excluded by MRI scan and there is no history of pain. There is a move towards the development of arthroscopic anatomical lateral ligament repair which may well take over from the open approaches that are currently performed in a similar way to how knee and shoulder ligament surgery has developed over the past 10–15 years. Anatomical reconstruction with tendon grafts/augmentation is preferable in the revision cases or those with gross laxity or insufficient innate tissue. Non-anatomical procedures should be avoided in these situations. Early reconstruction of acute ligament injuries may also be considered in the athlete as this improves stability, reducing the incidence subsequent complications from recurrent sprains without compromising or delaying return to sports.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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