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Injury & Reconstruction of Ligaments

Review

Concepts of ankle instability: A review

CC Hong[1], KJ Tan[2*]

Abstract

Introduction

Ankle sprains are very common. While most of them recover well, a significant number of patients will progress to develop chronic ankle instability (CAI). CAI encompasses the development of residual symptoms such as chronic pain, swelling and recurrent ankle sprains. We aim to describe the basic anatomy and injuries of the ankle ligaments, different concepts of ankle instability and the therapeutic options including rehabilitation approaches and surgical reconstruction with both open and arthroscopic techniques.

Discussion

CAI consists of 2 components namely the mechanical and functional instability. Both are treated with rehabilitative strategies initially and surgical treatment is indicated if rehabilitation failed. Anatomic reconstruction is recommended as it preserves the primary ligaments and restores the original mechanical stability.

Non-anatomic reconstruction has been described but poor outcomes ensue as it does not replicate the anatomical position of the lateral ligament complex. Anatomic reconstruction with autograft and allograft is used for failed primary repair or when primary ligaments are attenuated. The role of ankle arthroscopy is developing with good results from arthroscopic anatomical repair of the lateral ligament complex. In the recent years, it should be considered as a single surgical intervention to treat both concomitant intra-articular injuries and the primary lateral ligament pathology.

Conclusion

Chronic ankle instability is very common. The mechanical and functional components coexist and it is important to treat both components. Rehabilitative programs should always be first line treatment followed by surgical reconstruction for mechanical instability.

Arthroscopic technique allows simultaneous treatment of concomitant intra-articular pathologies and provides smaller wounds with potential earlier postoperative rehabilitation.

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Introduction

Ankle sprains are one of the most common sports injuries. An estimated 302,000 new ankle sprains occur every year in the United Kingdom[1]. It is reported that 30-75% of athletes who sustained a sprained ankle have long term impairments[2,3]. This results in significant loss of playing time for athletes and leads to other morbidities[2,3].

Residual symptoms such as pain, swelling, recurrent ankle sprains and subjective instability tend to occur after the initial sprain although there is no correlation between the severity of the initial sprain at the time of injury and the frequency of residual instability[4].

Braun reported 55 - 72% of their patients with ankle sprains presented with residual lifestyle limiting symptoms 6 to 18 months after the injury[5]. Yeung et al. reported that more than 70% of their patients had recurrent ankle sprains after the initial injury especially if they are national athletes requiring more frequent and higher intensity training[6]. This results in chronic ankle instability which encompasses the development of these residual instability symptoms such as recurrent episodes of ankle sprains. In this review article, we aim to describe the basic anatomy and injuries of the ankle ligaments, different concepts of ankle instability and the therapeutic options including rehabilitation approaches and surgical reconstruction with both open and arthroscopic techniques.

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.

Ankle stability

Ankle stability is governed by the interactions between 3 major contributors; the congruity of the articular surfaces (ankle mortise), the static ligamentous restraints and the musculotendinous units for dynamic stabilization[7,8,9]. The contribution of bony geometry to ankle joint stability relies on the degree of compression load applied and the position of the ankle joint whereby it is the most stable in dorsiflexion and eversion. The ankle is stabilized by the lateral ligament complex and deltoid ligament medially. The lateral ligament complex comprises of the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL) and the posterior talofibular ligament (PTFL).

The ATFL extends from the anterior edge of the lateral malleolus to the talar neck and blends with the anterior capsule. It is the most important lateral stabilizer of the ankle joint which limits the extent of supination, anterior translation, plantarflexion and internal rotation[7,8,9]. The CFL is extracapsular and lies deep to the peroneal tendon

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Review

sheath extending from the tip of the fibula to the lateral tubercle of the calcaneus[7,8,9]. The PTFL courses from the posterior border of the lateral malleolus to the lateral tubercle of the talus. It is the deepest and the strongest of the lateral ligament complex[7,8,9].

In an ankle sprain, the most commonly injured ligaments are the lateral ligament complex consisting of the ATFL followed by the CFL and less frequently, the PTFL. As a result of these injuries, recurrent episodes of ankle sprains can occur and lead to chronic ankle instability[7,8,9].

Concepts of Chronic Ankle Instability

Chronic Ankle Instability (CAI) is defined as the perception by the patient of an abnormal ankle with a plethora of symptoms including recurrent sprains, pain, swelling and avoidance of activities[10]. It is generally classified into two components; mechanical instability and functional instability. Mechanical instability is the actual anatomical instability. It occurs when motion exceeds the physiological limit of the joint and with the presence of incompetent stabilizing structures. Laxity of the ankle joint can be demonstrated clinically or radiologically in mechanical instability.

Functional instability is defined by Freeman in 1965 as the subjective feeling of giving way which may occur despite the absence of deviation beyond the physiological range of motion of the talus[11]. Patients may present with vague symptoms such as the sensation of the ankle or foot giving way easily. They may not have demonstrable clinical or radiological signs of laxity. It is thought to be attributed to proprioceptive and neuromuscular deficits. Hence, it is harder to define.

It has been reported in multiple studies that impaired proprioception such as abnormal peroneal muscle spindle activity and altered articular mechanoreceptor activity leads to functional instability of the ankle[4,7,8,11,12,13,14,15,16].

In addition, altered neuromuscular control such as impaired neuromuscular recruitment patterns, abnormal reflex response to inversion or supination and increased peroneal response time also contributes to functional instability[4,7,8,11,12,13,14,15,16].

Interactions between mechanical and functional instability give rise to repetitive injuries and the chronicity of the ankle instability. Patients at risks for CAI tend to be predisposed structurally and functionally.

Examples of structural predisposition are tibia vara, varus hindfoot alignment and incompetent stabilizing structures like ligaments[7,8]. Anatomical deviations of the tibiotalar joint such as talar dome rotation, axis of rotation and position of the lateral malleolus can also contribute to ankle instability[1,7,8]. On the other hand, functional predispositions are poor postural control, impaired proprioception, strength deficits and poor neuromuscular control[4,7,8,11,12,13,14,15,16].

Assessments

Assessments of mechanical instability can be divided to history and clinical tests. The history of an initial ankle sprain must precede the symptoms of CAI. The change in the level of activities must also be recorded to gauge the expected improvement after intervention. In terms of clinical tests, an initial assessment of the standing hindfoot alignment should be performed. The affected ankle should then be evaluated for range of motion and muscle strength. Following that, the anterior drawer test can be performed. The test is positive if the ankle can be translated anteriorly > 10mm in a plantarflexed position. The talar tilt can be examined clinically or radiographically on inversion stress. A positive test will show a talar tilt of > 10 degrees. In addition, assessment tools for functional ankle instability assesses the postural control and proprioceptive responses such as the star excursion balance test, peroneal reaction times, landing patterns and gound reaction forces and time to peak torque.

Imaging studies for assessment of CAI have been studied and reported. Standard plain radiographs include a weight bearing anteroposterior, lateral and mortise views of the ankle. Comparative stress radiographs using the anterior drawer test and talar tilt test may be used to assist in assessment as well. Van Bergeyk et al. reported in his study using Computed Tomography (CT) analysis of 14 chronically unstable ankles versus 12 controls to measure the hindfoot alignment and he found that there was a 6.4 versus 2.7 degrees of calcaneal varus in CAI patients[17].

Magnetic Resonance Imaging (MRI) evaluation is useful to rule out associated pathologies or when other

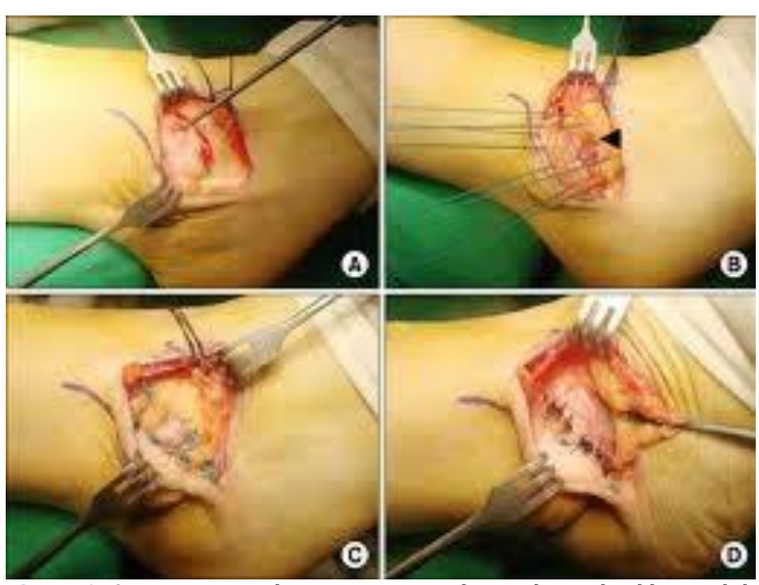

Figure 1: Open anatomical Brostrom repair for mechanical ankle instability.

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clinical findings such as tenderness and swelling warrant it. In a recent study by Khor and Tan, they performed MRI of the ankle for 64 patients with acute ankle inversion injury and found only 22% presented with isolated lateral ligament complex injuries but 78% of the patients had a multitude of concomitant injuries such as bone bruising, deltoid ligament injuries, tendon pathology, occult fractures and osteochondral lesions[18].

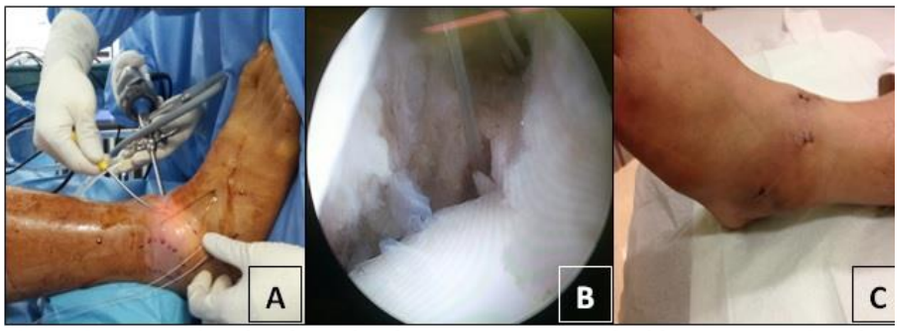

Figure 2: Picture A and B showed arthroscopic Brostrom-Gould repair using 2 anchor sutures. Picture C showed the small arthroscopic portal wounds postoperatively.

Management

Management for CAI are usually two pronged utilizing both functional strategies and surgical reconstructions. In the functional strategy group, graded exercise regimen is recommended to reduce risks of recurrent ankle sprains using proprioceptive, stretching and strengthening exercises concurrently[19, 20,21,22]. Proprioceptive exercises such as the Wobble Board exercise helps primarily to improve proprioceptive reflexes with secondary aims to develop balance, motor coordination skills and core ankle stabilization strength[19]. Strength training for the peroneal muscles are vital in absorbing stress and provide additional support to the lateral ligament complex[20,21].

Isokinetic dynamometry can be performed to identify and quantify the peroneal muscle weakness and monitor the progress of peroneal muscle strengthening programs. Ankle bracing have also been shown to decrease the frequency and severity of ankle sprains[22]. Rehabilitative programs should always be considered as first-line treatment in all patients with ankle instability whether it is functional instability or mechanical instability as studies have shown that patients will usually benefit from the improved proprioception and peroneal strengthening[19,20,21,22].

In patients with mechanical instability who are not improving despite rehabilitative programs may benefit from surgical reconstruction. Surgical reconstruction refers to the mechanical restoration of ankle stability consisting of anatomic and non-anatomic repair. Anatomic repair techniques involved the primary repair of the ruptured ligament ends. It was first described by Brostrom in 1966 which include midsubstance imbrication and suture of the ruptured ligament ends of ATFL and CFL[23]. The Brostrom technique then became one of the widely used techniques and the gold standard for primary lateral ligament repair with good or excellent outcomes in multiple studies (Figure 1).

Subsequently, Gould et al. demonstrated a modified technique to augment the primary repair with the proximal advancement of the inferior extensor retinaculum (IER) as an additional support[24]. This technique is easy to perform and has now been incorporated into the primary repair of lateral ligaments in most cases known as the Brostrom-Gould procedure. Karlsson et al. then described the technique on shortening and reattaching the ATFL and CFL to their anatomic origins through drill holes as they are often found to be elongated and scarred[25].

In addition, anatomic reconstruction with autograft or allograft such as the periosteal flap, plantaris, gracilis and semitendinosus have also been described with good success for failed primary reconstructions as these grafts are larger and stronger although there are risks of donor site morbidity for the autografts whilst there are risks of infection, rejection and higher cost for the allografts[26,27,28].

On the other hand, the non-anatomic repair was first popularized by Watson-Jones in 1952[29]. The Watson-Jones technique required the use of the peroneus brevis tendon graft which was detached proximally and weaved through the fibula from posterior to anterior and then to the lateral part of the talus and tenodesed[29]. The Evans procedure was simpler in that the peroneus brevis tendon graft was detached proximally and passed through a drill hole in the distal fibula anteroposteriorly[30].

Both techniques were not anatomical as the re-routed peroneus brevis tendon does not replicate the position of the ATFL or the CFL. Following that, Chrisman and Snook described a new technique meant to replicate the function of ATFL and CFL by weaving a split peroneus brevis tendon graft through the distal fibula anteroposteriorly and then to the lateral part of the calcaneus and tenodesed[31]. This technique preserves part of the peroneus brevis tendon to maintain some eversion function[31].

In the recent years, arthroscopic or arthroscopically assisted plication and suture anchor fixation techniques have been increasingly used to reconstruct the lateral ligament. Acevedo and Mangone demonstrated an all-arthroscopic lateral ligament reconstruction in 24 ankles with an average follow up of 10.9 months in 2011[32]. All reported significant functional improvement and ankle stability. Corte-Real and Mordeira performed an almost similar arthroscopic lateral ligament repair in 31 patients and reported good clinical outcome with AOFAS score at an average follow up of 24.5 months[33]. Nery et al. reported the long term

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outcome (mean follow up 9.8 years) in 2011 for 38 patients treated with arthroscopic assisted Brostrom-Gould procedure. Good to excellent outcome was achieved using the AOFAS score with a mean score of 90[34].

In a recent cadaveric study, Giza et al. performed open and arthroscopic anatomic Brostrom repair in 7 matched pairs of human cadaveric ankle and found no statistical difference in strength or stiffness of the traditional open repair when compared to the arthroscopic repair group[35]. This technique provides the advantage of smaller incisions, less dissection, lesser pain and potential early postoperative range of motion exercises[32,33,34,35]. (Figure 2)

On top of that, the role of arthroscopy is not only limited to surgical repair of the lateral ligaments in patients with mechanical instability. Kerr and colleagues recently reported on the role of arthroscopy in patients presenting with functional instability of the ankle[36]. They performed arthroscopy of the ankle in 72 patients with functional instability and found that 67 (93.1%) of them had significant amounts of scar tissue in the ankle joint with the commonest location being the antero-lateral corner (58.3%)[36]. 72.2% of the patients had improvement in their symptoms after arthroscopic procedures[36]. In addition, Gullish et al. evaluated 11 adolescent patients with chronic ankle pain and functional instability with ankle arthoscopy and reported good to excellent results with arthroscopic debridement of intra-articular soft tissue impingement lesions[37]. The average postoperative AOFAS score was 95 with 10 out 11 patients satisfied with the procedure and would have the procedure again if needed[37].

Concomitant pathologies in the ankle on top of isolated lateral ligament complex injuries have been described for patients with CAI[18,38,39]. Hintermann et al. reported that 66% of their 148 patients with lateral ankle instability had cartilage damage[38]. Ferkel and Chams performed arthroscopic evaluation of 21 ankles prior to a Brostrom-Gould procedure and found intra-articular pathologies in 95% of them[39]. Khor and Tan reported in their recent study that only 22% of their 64 patients with acute ankle inversion injury had isolated lateral ligament complex injuries on MRI while the other 78% of the patients had a spectrum of associated injuries such as bone bruising, deltoid ligament injuries, tendon pathology, occult fractures and osteochondral lesions[18].

In view of these findings, some surgeons advocate the use of arthroscopic technique to address the associated intra-articular pathologies. This allows the surgeon to use a single surgical approach to simultaneously tackle both the intra-articular ankle joint pathologies and repair the lateral ligament with a smaller wound and potentially early postoperative rehabilitation.

Conclusion

Chronic ankle instability is very common. The mechanical and functional components coexist and it is important to treat both components. Rehabilitative programs should always be first line treatment followed by surgical reconstruction for mechanical instability.

Arthroscopic technique allows simultaneous treatment of con-comitant intra-articular pathologies and provides smaller wounds with potential earlier postoperative rehabilitation.

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