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Copyright Year	2014	
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Abstract	Lateral ankle sprains are common sport-related injuries that may result in chronic pain and instability. The optimal management of chronic lateral ankle instability is still controversial. While approximately half of low-demand patients may benefit from a structured rehabilitation program, this is not acceptable for active people. Many surgical techniques have been described in the literature to restore ankle stability and function. The Broström technique aims to restore the normal lateral ankle ligaments complex anatomy and ankle motion. Intra-articular lesions such as loose bodies, synovitis, and osteochondral lesions are associated with chronic ankle instability and should be assessed and managed at the time of ligament stabilization because they may affect surgical long-term outcomes. Combined open and arthroscopic procedures could improve the diagnosis and management of intra-articular lesions and allow the surgeon to perform minimally invasive anatomic reconstruction of the lateral ligament complex.

Sports Injuries
DOI 10.1007/978-3-642-36801-1_142-1

Arthroscopic-Assisted Broström-Gould Repair

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Abstract

Lateral ankle sprains are common sport-related injuries that may result in chronic pain and instability. The optimal management of chronic lateral ankle instability is still controversial. While approximately half of low-demand patients may benefit from a structured rehabilitation program, this is not acceptable for active people. Many surgical techniques have been described in the literature to restore ankle stability and function. The Broström technique aims to restore the normal lateral ankle ligaments complex anatomy and ankle motion. Intra-articular lesions such as loose bodies, synovitis, and osteochondral lesions are associated with chronic ankle instability and should be assessed and managed at the time of ligament stabilization because they may affect surgical long-term outcomes. Combined open and arthroscopic procedures could improve the diagnosis and management of intra-articular lesions and allow the surgeon to perform minimally invasive anatomic reconstruction of the lateral ligament complex.

Introduction

Lateral ankle sprain is a common sport-related injury, and it accounts for up to 25 % of all musculoskeletal injuries. In the United Kingdom, 302,000 new ankle sprains are estimated to occur each year, with an incidence of 52.7 per 10,000 emergency department visits (Ferran and Maffulli 2006). Sprains involving the lateral ligament complex are more common than isolated medial ligament injury, accounting for 85 % of ankle lesions (Krips et al. 2006). Although lateral ankle sprains are commonly treated by most orthopedic surgeons in everyday practice with a high rate of success, they may result in pain and disability in the short term, decreased sport activity and early retirement from sports in the midterm (Ajis et al. 2006), and secondary injuries and development of early osteoarthritis in the long term (Ferran et al. 2009).

The ankle is stabilized by its bony configuration, the deltoid ligament medially, and the lateral ankle ligament complex. The deltoid ligament extends from the medial malleolus to the medial aspect of the talus. It is comprised of a strong deep layer which contributes most to stability, and a superficial fan-shaped layer (McMinn 1994). The lateral ligamentous complex consists of the anterior talofibular ligament (ATFL), the calcaneofibular ligament (CFL), and the posterior talofibular ligament (PTFL). The lateral talocalcaneal ligament (LTCL) may be present or not, and if present, it limits subtalar motion (Kumai et al. 2002). The ATFL is the primary restraint to inversion of the ankle throughout its arc of motion (Colville et al. 1990). Strain to the ATFL increases progressively as the ankle moves into plantar flexion and inversion. The CFL stabilizes

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DOI 10.1007/978-3-642-36801-1_142-1

both the ankle and the subtalar joints. Strain to the CFL is greater when the ankle is inverted and dorsiflexed. The most common mechanism of lateral ankle sprain is excessive inversion and internal rotation of the hindfoot, while the leg is in external rotation. The ATFL is the weakest of the three lateral ligaments, and it is most frequently injured in ankle sprains, while the CFL is involved in 50–75 % of such injuries, and the PTFL is rarely injured (less than 10 % of cases) unless complete dislocation occurs (Ferran et al. 2009). Patients with acute lateral ankle sprains usually respond to nonoperative measures, including physical therapy and functional rehabilitation. A level 1 evidence study showed that functional rehabilitation, in patients engaged in regular sports activity (Ardèvol et al. 2002), allowed earlier resumption of sports training, with fewer symptoms as compared with cast immobilization; however, about 15–20 % of patients with acute ligament ruptures will develop chronic instability (Krips et al. 2006).

Chronic Lateral Ankle Instability

To clearly define chronic lateral ankle instability, it is important to clarify the terms “laxity” and “instability,” which are often used as synonymous. Two types of ankle instability are described, functional and mechanical (Ferran et al. 2009). Mechanical instability is abnormal laxity of the ligamentous restraints, and it is a physical sign demonstrated on clinical examination. Functional instability is a symptom, and it refers to abnormal function, with recurrent episodes of the ankle giving way. The two types of instability can exist independently of one another, but often they occur together. Indeed, a patient with minimal mechanical instability (i.e., minimal laxity) can report giving way, that is, functional instability. Therefore, the terms “laxity” and “instability” should not be used as synonymous. Chronic ankle instability refers to repetitive episodes of instability resulting in recurrent ankle sprains (Hertel 2002). Persistent pain, recurrent sprains, and repeated instances of the ankle giving way are the hallmarks of chronic ankle instability.

The optimal management of chronic lateral ankle instability is still controversial. Low-demand patients may benefit from a structured rehabilitation program and external splinting in 50 % of cases. Patients with functional instability are more likely to benefit from rehabilitation than patients with mechanical instability (Ajis and Maffulli 2006). However, this treatment is not acceptable for most active people, especially high-level athletes. The primary indication for surgery is failure of nonsurgical management. Surgery aims to reestablish ankle stability and function, without compromising ankle motion. Many surgical techniques have been described with variable success, a testament to the complexity of this condition. These techniques and their modifications fall into three categories: non-anatomic tenodesis reconstruction, anatomic repair, and anatomic reconstruction. Non-anatomic reconstructions using local tendons have been proposed, but some concerns arise from their invasiveness, related risks of neurovascular injuries, postoperative subtalar and tibiotalar joint stiffness, and long-term degenerative joint disease in the ankle and subtalar joint (Caprio et al. 2006). The goal of anatomic repairs is to restore normal anatomy and joint mechanics and to maintain physiological ankle and subtalar motion (Maffulli et al. 2013).

The Broström technique forms the basis for other anatomic repair techniques (Broström 1966; Q1 Schmidt et al. 2004). Broström found that all patients with recurrent inversion instability had a tear of the ATFL and that an injury to the CFL was also present in about 30 % of cases (Broström 1966). More recently, a higher rate of combined injuries to the ATFL and the CFL has been demonstrated (Sugimoto et al. 2002; Ferran et al. 2009). The original technique involved midsubstance imbrication and suture of the ruptured ligament ends of ATFL and CFL. Bell et al. reported good or excellent functional results in 91 % of patients at 26-year follow-up (Bell et al. 2006). End-to-end repair of the

DOI 10.1007/978-3-642-36801-1_142-1

ruptured ligaments is possible even several years after the initial injury; however, such repair is dependent on the condition of the injured ligaments, which may be attenuated. In these cases, anatomic reconstruction has been recently developed to allow tendon grafts to anatomically recreate joint biomechanics. The anatomic repair originally described by Broström was later modified by Gould who strengthened the repair by augmentation with the mobilized lateral portion of the extensor retinaculum, which was attached to the fibula after imbrication of the ATFL and the CFL (Gould et al. 1980).

The Broström-Gould technique is often considered the standard because it is minimally disruptive of local anatomy, the augmentation with the extensor retinaculum should provide additional support against inversion, and it reduces pathological ankle joint laxity, with less motion restriction compared to more invasive reconstructions (Bahr et al. 1997). In a randomized controlled trial, the modified Broström procedure produced better outcomes and fewer complications at 2.5-year follow-up than the more complex Chrisman-Snook procedure (Hennrikus et al. 1996). Recent studies showed that anatomic repair of the ATFL provides similar biomechanical stability compared with the combined repair of the ATFL and CFL (Okuda et al. 1999; Lee et al. 2008, 2011). A biomechanical cadaver study, however, demonstrated that isolated ATFL repair augmented with retinaculum was as effective as repairing both ATFL and CFL with retinacular augmentation (Lee et al. 2008). Furthermore, the original work by Broström showed that in most patients, excellent results could be obtained with repair of only the ATFL (Broström 1966). Recent clinical and biomechanical investigation confirmed the impression that it is not necessary, in primary procedures, to repair the CFL as well (Lee et al. 2011).

Associated Lesions

Several intra-articular injuries are associated with chronic ankle instability, including osteochondral lesions of the talus, impingement, loose bodies, painful ossicles, adhesions, chondromalacia, and osteophytes. These conditions may produce ankle pain, and they may affect surgical long-term results. In fact, 13–35 % of patients complain of persistent postoperative pain, probably related to unidentified and/or improperly managed intra-articular lesions (Ajis et al. 2006). Komenda and Ferkel found that 93 % of patients had intra-articular lesions requiring intervention during arthroscopic assessment of the ankle at the time of ligament repair (Komenda and Ferkel 1999).

Osteochondral lesions of the talus are considered the strongest indicators for poor clinical Q2 outcomes (Hintermann et al. 2010). Although several studies have reported patients with chronic lateral ankle instability and concomitant chondral lesions (van Dijk et al. 1996; Okuda et al. 1999; Hintermann et al. 2002), the real influence of these injuries on the long-term results has not been well established. Gregush and Ferkel (2010) reported that concomitant arthroscopic management of osteochondral lesions and open lateral ankle stabilization is safe and effective, but osteochondral lesions may impair the overall results in the long term. Nery et al. (2011) recently reported that patients with cartilage lesions managed with microfracture showed no significantly different AOFAS scores compared with patients with no chondral disease. On the other hand, other authors did not find any correlation between focal chondral lesions and postoperative pain (Okuda et al. 1999). Cannon and Hackney (2000) reported good results after removal of bony spurs in patients with chronic ankle instability. Other intra-articular conditions such as synovitis, hypertrophic synovial thickening, and soft-tissue impingement may also cause persistent postoperative pain (Maffulli et al. 2013). Hence, many authors recommend ankle arthroscopy at the time of surgical repair.

DOI 10.1007/978-3-642-36801-1_142-1

For the reasons outlined above, combined arthroscopic ankle evaluation and open isolated ATFL repair for chronic lateral ankle instability is described.

Surgical Technique

The patient is positioned supine without any distraction devices. After exsanguination, a thigh tourniquet is inflated to 300 mmHg. A standard knee arthroscope and two standard anteromedial and anterolateral portals are used, switching to a 2.7 mm 30° angled arthroscope if needed. All structures are palpated with a probe to assess osteochondral and bony features and the presence of soft-tissue impingement. Bony and soft-tissue debridements are performed. Osteochondral lesions are treated as appropriate. After the arthroscopy, a slightly curvilinear 2–2.5 cm incision anterior to the anterior border of the lateral malleolus is made, 2 cm distal to the tip of the fibula, to avoid injury to the medial dorsal cutaneous nerve and/or the intermediate dorsal cutaneous nerve. After removal of all the adhesions to the surrounding soft tissues, the ATFL is exposed (Fig. 1). The ligament is sutured with strong absorbable sutures in a vest-over-pants fashion (Fig. 2), without using transosseous tunnels or suture anchor systems. Under anesthesia, the tension of the construct and the clinical stability are tested with the ankle in slight eversion, flexed at 90°. After thorough irrigation with normal saline, the skin incisions are sutured with 3.0 Biosyn (Tyco Healthcare, Norwalk, CT) and

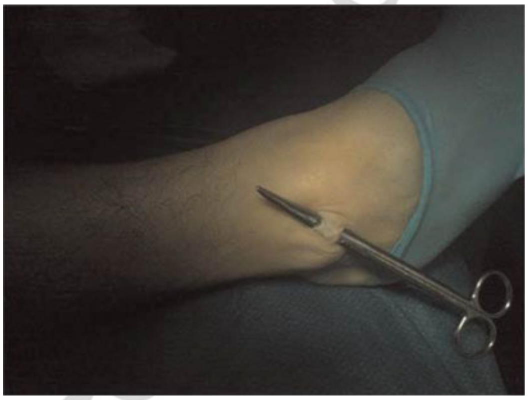

Fig. 1 After removal of all the adhesions to the surrounding soft tissues, the anterior talofibular ligament is exposed

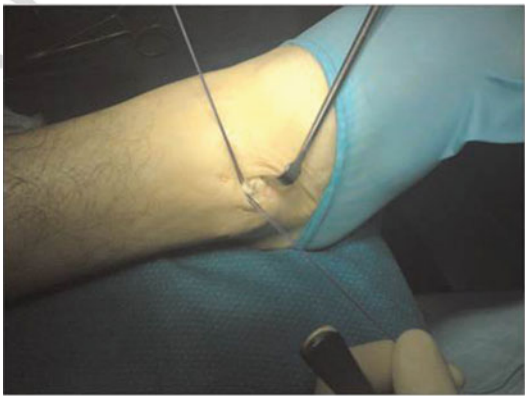

Fig. 2 Repair with strong absorbable sutures in a vest-over-pant fashion

DOI 10.1007/978-3-642-36801-1_142-1

Steri-strips (3 M Health Care, St Paul, MN) are applied. A below-knee weight-bearing synthetic cast is applied with the foot in neutral, and weight bearing is allowed as able for the first two postoperative weeks. At 4 weeks, the cast is removed and physical therapies, including proprioceptive training, active ankle extension, and eversion exercises, are started, with the ankle in a semirigid brace. Stationary cycling is allowed from the sixth postoperative week. Running and swimming are introduced by 3 months, and return to high-impact sports is allowed at 6 months.

Discussion

Sprains involving the lateral ligament complex of the ankle are common injuries in athletes: they may result in long-term disability. Many surgical techniques have been described to manage chronic lateral ankle instability, but there is a lack of level 1 evidence studies. At present, the Broström-Gould repair is increasingly being considered the procedure of choice when the quality of the affected ligaments permits (Li et al. 2009).

Since intra-articular injuries are considered indicators for poor clinical outcomes, arthroscopic assessment of the joint followed by a Broström repair should be considered. Hamilton et al. (1993) recommended full assessment of associated painful lesions before the modified Broström repair. Corte-Real and Moreira (2009) performed a similar procedure in 28 patients, with an average AOFAS score of 85.3/100 at a mean follow-up of 24.5 months. Long-term outcomes of 38 patients treated with ankle arthroscopy and anatomical repair of the ATFL have been recently published (Maffulli et al. 2013). The authors found that isolated repair of the ATFL was easy, fast to perform, inexpensive, and provided a high rate of good-excellent outcomes in the long term, allowing the majority of patients to remain active at the pre-injury level of sport activity at 9 years from surgery. However, 16 % of patients developed mechanical and functional instability after surgery.

Arthroscopic management of lateral ankle instability is an emerging modality that may have benefits of faster rehabilitation and less soft-tissue damage; however, it remains technically demanding and few long-term results are available. Hawkins first described arthroscopic stapling of the ATFL with good short-term results (Hawkins 1987). Lui described an arthroscopic-assisted, autogenous tendon reconstruction for lateral ankle instability using a three-portal approach (Lui 2007). Recently Nery et al. (2011) reported excellent or good results at 9.8 years follow-up after arthroscopic anatomic repair of the lateral ligament complex using an arthroscopic-assisted Broström-Gould procedure and a three-portal approach. Compared with the standard Broström-Gould technique, the arthroscopic-assisted procedure provides similar outcomes, avoids long incisions, and preserves the dynamic stabilizer of this joint. Fully arthroscopic management of CFL ruptures is difficult to perform and often requires an open approach. Biomechanical cadaver studies showed that isolated ATFL repair augmented with retinaculum was as effective as repairing both ATFL and CFL, questioning the role of open CFL repair from a biomechanical point of view (Lee et al. 2008). However, the repair methods tested were open, and biomechanical testing of arthroscopic techniques remains an area for future research.

Arthroscopic and arthroscopically assisted plication and anchor fixation techniques have been increasingly used, attaching the ATFL to the talus and/or fibula. Suture anchors may successfully reattach the lateral ligament tissue to an anatomically normal position, but they may disadvantageously result in malpositioning, breakage, pullout, and additional costs (Giza et al. 2012). Repairing the ATFL using simple stitches, without using transosseous tunnels or suture anchor systems, may be a good compromise. It allows anatomical repair with minimal dissection and irritation of soft tissues and without bone exposure. Furthermore, the simplicity and minimal

DOI 10.1007/978-3-642-36801-1_142-1

invasiveness of this procedure decrease operating time and the risk of potential fractures secondary to multiple drill holes.

Conclusion

Anatomical repairs of lateral ankle ligaments may improve the long-term results. They restore normal ankle and subtalar motion and rotational stability and ensure high mechanical restraints. Intra-articular lesions such as loose bodies, synovitis, and osteochondral lesions should be assessed and managed at the time of ligament stabilization. Combined open and arthroscopic procedures could improve the diagnosis and management of intra-articular lesions and allow the surgeon to perform minimally invasive anatomic reconstruction of the lateral ligament complex.

Cross-References

► Arthroscopic Assisted Bostrom-Gould Repair
► Arthroscopy of the Ankle: New Approaches
► Chronic Ankle Instability
► Functional Anatomy of the Ankle
► Ligamentous Injuries of the Ankle: Sprained Ankle
► Natural Course of the Ankle Injury: Based on Volleyball Experience

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Sports Injuries
DOI 10.1007/978-3-642-36801-1_142-1

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DOI 10.1007/978-3-642-36801-1_142-1

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