The anterior talo-fibular ligament reconstruction in surgical treatment of chronic lateral ankle instability

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Abstract Chronic lateral ankle instability causes significant problems in physical activity and accelerates development of osteoarthritic changes. The results of treatment for chronic ankle instability are often meets controversial. A surgical reconstruction of ATFL as described in this paper was performed during the period 1997–2005 on 47 patients (26 male, 21 female), with a mean age of 29.3 years. The average follow-up period was 46.2 months. All patients had clinical examination, X-ray and MRI. The mean values of the Good score improved from an average 3.32 prior to surgery to 1.19 one year after the operation. Paired *t*-tests showed improvements of great significance ($p < 10^{-28}$). The Good score prior to surgery ranged from 2–4, whereas the scores one year after surgery were either 1 or 2, with a score of 1 being recorded in 38 cases (81%). In the postoperative follow-up, MRI showed a newly-formed ligament structure in all cases. The authors describe their own technique for a reconstruction of lateral ankle instability using remnants of the former ATFL. The scar tissue seems to be sufficient to form a new duplicated structure providing good stability. MRI proved to be a sensitive and specific method for identifying the extent of talo-fibular ligament injury.

Introduction

Chronic ankle joint lateral instability after a severe sprain or repetitive injury is a very common pathology in the

active population. It usually causes significant problems in gait or during high-level physical activity (jogging, jumping, skiing, etc.) and accelerates possible development of osteoarthritic changes of the talo-crural joint.

Each day about one inversion injury of the ankle occurs for every 10,000 people. Seven to ten percent of all admissions to hospital emergency departments are attributed to ankle sprains. It has also been documented that the ankle sprain injury is more common in individuals under 35 years of age, meaning that this injury mostly involves a young active population [3].

Structures supporting the ankle stability are included in the lateral ligament complex which is formed by three capsular ligaments: the anterior talofibular (ATFL), calcaneofibular (CFL) and posterior talofibular (PTFL). The ATFL and the CFL are the primary stabilisers of the lateral side of the ankle. A lesser influence can be attributed to the PTFL [2, 3, 14, 19]. A typical mechanism of the sprain injury is plantar flexion and inversion when the ATFL is most commonly torn. The continuing severe force of inversion can also cause both the CFL and the PTFL to tear. In this case subtalar joint ligaments can also be injured [3, 8, 14, 17, 19].

Symptoms typically seen are persistent ankle stiffness, swelling and pain with delayed synovitis, tendinitis and muscle weakness. The ‘giving-way’ phenomenon can often be observed [19]. Making a reliable and accurate diagnosis is not so easy because some of the symptoms are dependent upon the patient’s subjective feelings of instability being present at the time of examination. Clinical stability tests for torn ligaments are the anterior drawer test of ATFL function and the inversion tilt test of both ATFL and CFL function. The anterior drawer test is used to assess the integrity of the ATFL, while the inversion tilt test assesses both the ATFL and CFL. The observations gained from these tests may be difficult to interpret and conclusions often vary greatly between examiners; however, a positive

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test can confirm a diagnosis suspected on the basis of the patient's history [3, 14, 17, 19].

Conventional X-ray stress images are used in the diagnostics of lateral ankle instability. They can also include evaluation with inversion and anterior drawer stress radiography, arthrography, and tenography [1, 5, 18, 24]. Magnetic resonance imaging (MRI) has recently taken a position of the most noninvasive and accurate imaging modality of choice for evaluating acute ligament injuries. Unlike radiography, MRI provides information on bone marrow, cartilage and soft-tissue damage, and several authors have reported that the talofibular ligaments can be well visualised using this noninvasive method [5, 18, 21, 22].

Typically, ankle sprains are treated according to their severity and grading [19]. The most common classification of ankle sprains used in a clinical practice differentiates grade I (mild), grade II (moderate) and grade III (severe) [9, 14, 17, 19]. Grades I and II generally recover with conservative management. The treatment of grade III sprains is more controversial. There are two main views with respect to treatment. The first group favours primary surgical repair [3, 12, 13, 15, 17, 23, 25], whilst the second prefers conservative treatment [6, 10, 11].

In our hands, surgical treatment to restore normal function of the ankle and its ligaments is recommended in patients suffering from pain and feelings of gait instability, especially on uneven terrain based on a chronic lesion of ATFL, despite the fact that this treatment very often meets with controversial results. More than 50 surgical techniques have been described for reconstructing ankle ligaments and correcting ankle instability, most with 80–90% success rate [3, 12, 13, 15–17, 23, 25].

We present our own modification of technique for reconstruction of grade III ankle instability using remnants of the former ATFL.

Material and methods

Surgical reconstruction of the ATFL as described by the first author was performed during the period 1997–2005 on 47 patients (26 male, 21 female), with a mean age of 29.3 years (range 16.5–47.9 years). The average follow-up period was 46.2 months (range 8–96 months).

At surgery, there were 47 isolated ATFL tears; no combination of both ATFL and CFL tears was included in the study. The PTF ligament was intact in all patients.

All patients had a history of either recurrent ankle sprains or a chronic post-traumatic ankle instability combined with pain. None of the patients responded to initial conservative therapy that included immobilisation and early aggressive rehabilitation when the chronic instability

occurred. Each patient presented with symptoms of at least 12 months duration. The pre-operative clinical findings were typical in most cases—oedema was absent and the stretching tests were painful, especially at the talar attachment of ATFL. Sensations of pain on palpation also usually originated from this location. An anterior drawer test was obtainable in 36 cases (76.60%); however, the drawer test was positive in all patients when performed under general anaesthesia.

The diagnosis of a torn ATFL was always confirmed by standard stress X-ray examination and MRI. In the X-ray diagnostics, the tibio-talar angle and the distance were measured and recorded. Standard stress X-rays were obtained in the anteroposterior (AP) and lateral projections when inversion and anterior drawer stresses were applied. The results of stress radiography were considered to be positive for ATFL rupture according to the standard criteria when the tibio-talar angle was more than 10° on the AP or when the tibio-talar distance was more than 6 mm on the lateral radiographs.

MR images were acquired both pre- and postoperatively (at six to 12 weeks) with a 0.2-T E-scan XQ dedicated extremity open MRI system (Esaote, Genoa, Italy), using a dedicated foot/ankle coil. The patient's foot was placed in a slightly plantar-flexed position, comfortable for the patient, and fixed with pads. The MRI protocol consisted of transverse images, sagittal (and/or coronal) T1-weighted spin-echo images, coronal images, and transverse (and/or sagittal) short time inversion-recovery (STIR) images. The normal ATFL is readily identified on T1-weighted axial images as a linear, thin, low-signal intensity band extending from the caudal aspect of the fibular malleolus to the talar bone, slightly caudal to the tibiofibular ligaments [5, 18, 21, 22]. ATFL injury was morphologically identified as a thicker, irregular, wavy contour or as a clear discontinuity or non-visualisation of the ligament (Fig. 1).

The surgical technique for AFTL reconstruction

It is the authors' own view, based upon the experience of Brostrom [4], that it is possible to reliably distinguish both the remnants of the ATFLs original attachments and also the scar tissue in the original anatomical position of the ligament.

The patient lies in a supine position with the lower extremity in interior rotation and slightly elevated. A mini-invasive open technique is used with skin incision starting 2 cm proximally from the apex of the fibula along its posterior rim, distally running in parallel with the foot, roughly along the former ligament position. The length of the incision is about 5 cm. The weakened remnants of the ligament are identified. The fibular attachment and the talar neck serve as the orientation points. It is usually possible to create a 1 cm-wide strip of scar tissue in the former

Fig. 1 Coronal pre-operative MR image of right ankle showing torn anterior talofibular (ATFL) as a clear discontinuity of the ligament (see arrow)

ligament position (Fig. 2). H-shaped incision of this strip is performed next, with the medial cut dividing the strip into proximal and distal flaps.

Once the two flaps are identified, a PDS (polydioxanone) suture material is loaded through the end of the proximal flap to the talar attachment of the distal flap. Similarly, the end of the distal flap is guided to the fibular attachment of the proximal flap (Fig. 3). These two steps provide adequate duplication of the flaps with both ends

Fig. 2 Surgical identification of scar tissue in the former anterior talofibular (ATFL) position (left foot)

Fig. 3 Technique of the PDS (polydioxanone) suture guidance through the proximal and distal flaps of the anterior talofibular (ATFL) providing duplication of the torn ligament

securely fixed to healthy and well vascularised tissue at the origins of the former ligament (Fig. 4).

A plaster cast at a 90-degree angle and slight pronation is applied postoperatively. Heel walking with partial weight bearing through full plaster for six weeks is initiated in the second postoperative week. A structured rehabilitation program begins with extension-flexion training, avoiding supination and pronation movements for the first four weeks after plaster removal. Full ROM and progressive sports activity is allowed three months after the operation.

Results

The follow-up evaluation included clinical scoring according to Good et al. [9] and a follow up MRI. The imaging

Fig. 4 Schematic view of the anterior talofibular (ATFL) flaps duplication

findings were correlated with the perioperative findings that were used as the standard of reference.

The mean values of the Good scores improved from 3.32 prior to surgery to 1.19 one year after the operation was performed. Paired *t*-tests showed improvements of great significance ($p < 10^{-28}$). The Good scores prior to surgery ranged from 2–4, with a value of 2 being recorded in only one case, whereas the scores one year after surgery were either 1 or 2 only, with a score of 1 being recorded in 38 cases (81%). Considering individual recovery measured by actual Good score improvement, the mean value of improvement was 92.55%.

The patients' recovery (considering the individual Good score improvement) was also evaluated for three different age groups and another three groups with varying degree of severity in their X-ray findings prior to surgery. There was no proven significant correlation of improvement of individuals based on age or preoperative clinical findings ($p > 0.01$). Very good recovery results were found in all groups, with individual improvement ranging from 88.54% for the most serious cases (tibiotalar angle 19° – 24°) to 100% for the less serious cases (tibiotalar angle 11° – 15°). The recovery of patients according to mean Good test score values with respect to age and prior X-ray tibiotalar angle evaluation are shown in Tables 1 and 2.

The mean value of the tibiotalar angle measured on stress X-rays was 18.50° (range 11° – 26° , i.e. over the limit value of 10°). The mean value of the tibiotalar distance was 9.8 mm (range 6–13 mm, i.e. exceeding the 6-mm limit).

When compared with the surgical findings, the MRI demonstrated the exact extent of the ATFL injuries in 47 of 47 cases preoperatively. There were no false-positive findings. In each case the postoperative MRI showed a newly-formed ligament structure at the former ATFL position as an accentuated scar tissue in the position of the former ATFL rather than a clearly-developed new ligament (Fig. 5). Satisfactory MRI diagnostic results were obtained for all of the patients in this study.

Table 1 Mean values of clinical Good score prior to and one year after surgery with standard deviations; patients sorted according to age

Table 2 Mean values of clinical Good score prior to and one year after surgery with standard deviations; patients sorted according to pre-surgical radiographic evaluation

Discussion

The surgical approach to lateral ankle instability is based on the anatomy of the lateral ankle ligaments. Chronic ankle instability can be differentiated as being either functional or mechanical. Mechanical instability can be measured based on either X-ray, MRI or clinical examination [1–5, 9, 14, 17, 22].

In standard stress X-rays the range of normal angular values are compared with those of the affected ankle. Results are dependent on various factors, for example, the position of the patient's foot, the force applied to the foot and its ability to withstand the force, etc. In fact, we lack the criteria to distinguish tears of one ligament from those of a combination of ligaments [4, 5, 14, 19, 22, 24, 25]. In

Fig. 5 Postoperative coronal T1 MR image of right ankle showing healing progress of the anterior talofibular (ATFL) with the flaps duplication (see arrow)

detecting an injury of the ATFL and/or CFL it is also important to document their exact extent. The value of stress radiographs is questionable because of oedema, muscle spasms and the patient's reactions to pain that can affect the radiographic technique [24].

Sonography has rarely been suggested for assessment of the ankle joint and its efficacy for a direct evaluation of ligament pathology still remains limited [8].

MRI can be fully employed when evaluation of ligaments and associated soft-tissue structures are required. Several studies have proved that MRI is perfectly capable of depicting the anatomy as well as the extent of injuries of the ATFL and CFL. Unlike radiography, the MRI provides good visualisation of all relevant ligamentous structures of the ankle, including the ATFL [5, 18, 21, 22]. However, the routine use of MRI in acute musculoskeletal injuries is still restricted by its cost and limited availability. In our MRI department, the introduction of a low-field-strength extremity MRI system has created the possibility for using MR imaging more routinely for the initial evaluation of musculoskeletal trauma. We are aware of the fact that a low-field MRI system may be associated with some loss of image quality and accuracy according to some authors [20], but in our experience the images obtained provided satisfactory results with regard to the clinical demands. When compared with a high-field MRI system, however, it is conceivable that the performance of the latter would be better.

Patients with chronic ankle instability are often treated by surgical repair. The decision for a specific type of surgical procedure chosen for a repair is usually based on the degree of ankle instability, the occupational or athletic demands of the patient, and the surgeon's experience.

The Watson-Jones surgical technique using the short peroneal tendon is one of the most popular procedures [15]. Hoy and Henderson reported very good results using the Watson-Jones technique, and they did not confirm any relation to subtalar degeneration [15]. They only found postoperative instability in two cases out of 30 patients. Most of their patients suffered from limited ROM and painful sensations however. Horstmann et al. also describe a great deal of pain with the Watson-Jones procedure in most cases [14].

The Chrisman-Snook procedure [12] uses tendon transfer to reconstruct the two lateral ankle ligaments individually. The commonly accepted Evans procedure employs tendon transfer to place the tendon between the ATFL and CFL [7]. Hintermann and Regli describe anatomical reconstruction using the plantaris tendon without weakening the peroneal muscles [13]. Saragaglia demonstrated a procedure using extensor retinaculum [23].

Ankle reconstruction procedures using tendons are said to provide better stability. However, this increased stability

usually results in a loss of ROM in the talo-crural and subtalar joints, prolonging recovery and decreasing sporting performance. In addition, a concomitant nerve injury is more common with ankle-ligament reconstruction [2, 7, 12, 14, 15, 23].

Brostrom carried out one of the most extensive clinical studies of ankle ligament injuries [4]. He found isolated complete rupture of the ATFL present in 65% of acute ankle sprains and a combined rupture of the ATFL and the CFL in 20% of his patients.

So-called anatomical reconstructions are based upon Brostrom's work and on the knowledge that even after a longer period it is possible to create a structure similar to the former ligament. Brostrom attaches this abbreviated scar tissue intraosseally [4]. Karlsson and Lansinger shorten these structures and reconstruct fibulocalcaneal ligaments in a very similar fashion [17]. In our technique we duplicate the scar tissue with a firm connection of both ends to the relatively unwounded origin of the former ligament adjacent to its bony insert on each side.

We believe that the anatomical ATFL reconstruction (with shortening, re-insertion and imbrication of the healed but elongated ligament) is a simple procedure with good short- and long-term results, which may often be an alternative to other more complex reconstructive procedures [2, 4, 17]. Some authors however also describe disadvantages. Brostrom [4] described restricted foot inversion and also increasing pain with progressive forefoot loading in about 40% of patients.

Reconstructing lateral ankle stability by duplication, reinserting and reinforcement of ATFL as an isolated procedure is a safe and simple method. It also avoids the morbidity that is more probable in tendon graft procedures. We agree with those confirming that the anatomical reconstruction is a good alternative to other more complex techniques of ligament reconstruction [2, 4, 9, 12, 16, 17, 25].

Conclusions

The described technique of ATFL reconstruction gives an alternative to other procedures in treatment of a chronic lateral ankle instability. The surgical exposure is a very simple, anatomical procedure, which provides increased stability by reinforcing the scar tissue of ATFL, preserves subtalar and talocrural motion, eliminates possible comorbidity associated with tendon-graft harvest, and offers a quick functional recovery with very good clinical outcomes.

We believe that with almost 80% excellent or good results, this procedure becomes comparable or better than other techniques widely used for ATFL reconstruction.

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