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ORIGINAL STUDY

Outcome after arthroscopically assisted percutaneous reconstruction of lateral ankle ligaments using a gracilis tendon autograft

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In cases of chronic instability of the lateral ligament complex following an ankle sprain, operative stabilization should be considered when conservative treatment fails. The purpose of this study is to determine the outcome of a percutaneous stabilization of the lateral ligament complex with a gracilis tendon autograft, after an adjuvant arthroscopy of the ankle joint. We retrospectively reviewed the medical files of patients who underwent this surgery performed by the senior author. Between 2012 and 2015, 18 ankles were stabilized. Clinical results were assessed at final follow-up at a mean post-operative period of 25 months (range, 10-42 months). The mean post-operative AOFAS ankle-hindfoot score was 90 points (range, 48-100 points). The mean Karlsson Ankle Functional Score was 85 points (range, 37-100 points). The mean VAS score was 1.2 (range, 0-7). Concomitant procedures were performed on 14 out of 18 ankles. In conclusion, we state that this arthroscopically assisted percutaneous technique is a viable treatment option for chronic lateral ankle instability. It offers an alternative for the modified Broström procedure when tissue quality is poor and carries all the advantages of a minimally invasive procedure.

Keywords : ankle instability ; hamstring tendon autograft ; gracilis.

INTRODUCTION

Ankle sprains are amongst the most frequently encountered musculoskeletal injuries in athletes, accounting for nearly 20% of all sports related injuries *(42)*.

The talus is settled in between the medial and lateral malleolus and sits on top of the calcaneus. This bony architecture is responsible for the primary stability of the ankle joint. During gait the talus neutralizes the shearing forces, due to the geometry and sagittal orientation of the articular surfaces of the talus *(2)*.

The ligamentous envelope further stabilizes the talus in the ankle joint, together with the muscles surrounding the ankle and a complex proprioceptive system.

During a classical ankle sprain the lateral ligament complex (LLC) is most frequently injured *(7)*.

The LLC consists of the anterior tibio-fibular ligament (ATFL), calcaneo-fibular ligament (CFL) and posterior tibio-fibular ligament (PTFL), mentioned in order of susceptibility to injury during an inversion trauma *(6,33,35)*.

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The ATFL's primary function is to restrict anterior translation, excessive internal rotation and inversion of the talus from the tibia with the ankle in plantarflexion *(6)*.

Lateral stability in a neutral and dorsiflexed ankle is provided by the CFL and the stronger PTFL *(33)*. The CFL also stabilizes the subtalar joint, together with the extensor retinaculum and the interosseous talocalcaneal ligament (ITCL). A concomitant lesion to the LCL and ITCL can give rise to a rotational instability *(35,39,40)*.

The mainstay of treatment after an acute ankle sprain consists of functional rehabilitation with early proprioceptive exercises after a short period of rest *(1,26)*, but residual symptoms at more than 6 months after trauma occur in up to 40% *(9,10,13,21)*. These symptoms include chronical pain, swelling, recurrent giving way and manifest instability *(4,14)*.

Recent literature shows that chronical instability can be a determinant factor for arthritic changes in the ankle joint *(41)*.

When failure occurs after a functional conservative treatment, operative stabilization of the lateral ligament complex may not only be required to improve function, swelling and pain, but also to prevent ankle osteoarthritis *(24,27)*.

A multitude of operative techniques are described in the literature.

The Broström procedure with the Gould *(16)* or Karlsson *(23)* modification is widely accepted as the golden standard for the treatment of symptomatic chronic lateral ankle instability. It's an anatomic repair procedure which means that secondary suturing of pre-existing torn ligaments is used to provide adequate stability.

However, when the quality of the available ligamentous tissue is not adequate for repair due to repetitive sprains, a ligament reconstruction has to be performed instead.

Roughly we can distinguish two major reconstruction techniques, namely the anatomical and the non-anatomical reconstruction.

Most non-anatomic reconstruction techniques for the lateral ankle ligament complex make use of a tenodesis of the short peroneal tendon *(12,43)*.

Mainly by overtightening the hindfoot, these non-anatomic procedures are known to have disappointing longterm results. Low overall satisfaction and functional outcome, decreased mobility of the hindfoot, recurrence of instability and an increased incidence of subtalar joint osteoarthritis have all been reported *(30,38)*.

Furthermore, sacrificing (part of) the short peroneal tendon may weaken the eversion force of the ankle.

Anatomic reconstruction techniques using tendon allografts *(5, 1,19,22)* or autografts *(3,8)* do not restrict subtalar motion and give far better results *(8,10,19,22,32,34)*.

The purpose of this article is to describe the outcome of a percutaneous stabilization of the LLC with a gracilis tendon autograft (PSLG), after an adjuvant arthroscopy of the ankle joint.

MATERIALS AND METHODS

We performed a retrospective review of our database after obtaining approval of our institutional Ethical Committee (EudraCT number B009201628735, E.C. approval number 4788). All files of patients who underwent a PSGL between November 2012 and September 2015 were collected and reviewed for operative reports, as well as pre- and postoperative clinical notes.

All of the procedures were performed by the same senior author (KB) under general anesthesia, some combined with a popliteal block.

Inclusion criteria were a symptomatic and clinically unstable ankle with an incompetent ATFL (anterior drawer test) and CFL (talar tilt test), despite an appropriate non-operative functional rehabilitation program of at least 6 months.

Exclusion criteria were revision surgery and hyperlaxity of the ankle joint. Concomitant syndesmotic lesions or rotational medial and lateral instability of the ankle joint were also excluded in this study.

Pre-operative weight-bearing radiographs of the ankle were routinely obtained in all patients to screen for malalignment and osteoarthritis. MRI scans were also performed to evaluate the involvement of the different lateral ligaments and to look for associated intra-articular lesions.

Clinical results were assessed at final follow-up at a mean of 25 months post-operatively, ranging from 10 to 42 months. Post-operative scoring was performed by the junior author (MC).

We used following scoring systems : the American Orthopedic Foot and Ankle Society (AOFAS) ankle-hindfoot score, Karlsson Ankle Functional Score (KAFS) and Visual Analogue Scale (VAS).

The AOFAS ankle-hindfoot questionnaire is a reporting tool that requires both patient and clinician participation. It consists of nine items distributed over three categories with a maximum score of 100 points : pain (40 points), function (50 points) and alignment (10 points).

The Karlsson Ankle Functional Score (KAFS) is a validated disease-specific questionnaire to evaluate function of the ankle *(25)*.

The Visual Analogue Scale (VAS) was used to quantify pain levels : 0 means no pain, 10 is the worst pain imaginable.

We also asked the patients to rate their satisfaction with the outcome of surgery as excellent, good, fair or poor.

Prior to disinfection and draping, stress tests under fluoroscopy are performed to detect syndesmotic lesions or rotational instability. If present, this was documented and these patients were excluded from this study.

A classical anterior arthroscopy is performed using an antero-medial and antero-lateral portal.

The antero-medial portal is placed at the joint level line, medial to the anterior tibial tendon.

The antero-lateral portal is placed proximal to the joint line, more lateral than usual to the peroneus tertius tendon, after drawing out the anatomical landmarks of the superficial peroneal nerve. This slightly more lateral position is helpful for placing the talar anchorage of the gracilis graft in the second stage of the surgery (Figure 1-2).

A third lateral portal is placed more distal over the lateral gutter if debridement of the latter is indicated.

A full inspection of the talocrural joint is performed, assessing any intra-articular lesions and the quality of the LLC.

All intra-articular lesions are treated and noted in the operative protocol.

In the second stage of the operation a gracilis autograft is harvested from the ipsilateral knee, using an open tendon stripper.

A minimal tendon length of 135 mm is obtained for the reconstruction of both the ATFL and CF ligament. After debridement of the muscle-tendon junction, both ends of the graft are whip stitched using a No. 2 Fiber-Wire (Arthrex Inc., Naples, FL, USA).

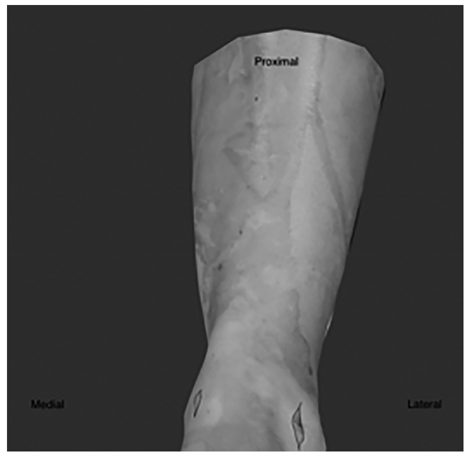

Figure 1. — Location of the incisions (anterior view).

Figure 2. — Location of the incisions (lateral view).

A separate incision of about 1cm is centered over the distal fibula. 2 bone tunnels are created in the fibula after identification of the peroneal tendons. The first tunnel starts at the anterior border of the fibula near the insertion point of the native ATFL, from anterior to posterior.

The second tunnel is directed from posterior to anterior in an oblique way.

The anterolateral portal of the arthroscopy is used to create a small arthrotomy and a bone tunnel is created in the talus at the isometric point of the ATFL insertion.

The tunnels are made with a 5.5 mm diameter drill bit.

A soft tissue tunnel is made from the fibular incision to the talar tunnel.

The anterior limb of the graft is then pulled from anterior to posterior in the first fibular tunnel.

The anterior limb is then brought into the soft tissue tunnel and secured in the talar bone tunnel with a 5.5 mm bio-tenodesis screw (Arthrex Inc.).

Bio-tenodesis screws eliminate the need for transosseous tunnels, as tension on the autograft can be maintained during insertion of the screw.

A small cushion is placed proximal to the calcaneum to let the heel loose. The ankle is brought into 90° and slight pronation and the graft is secured in the fibular tunnel, thus mimicking the ATFL.

A stab incision is made distal to the tip of the fibula and the peroneal tendons at the level of the calcaneum, followed by the creation of a third bone tunnel using the same drill guide.

A soft tissue tunnel is made from the tip of the fibula underneath the peroneal tendons.

The posterior limb of the graft is then brought from posterior to anterior in the oblique fibular tunnel and through the soft tissue tunnel into the third bony tunnel (calcaneum).

The ankle is reduced in the same position as described above and the graft is secured with a third bio-tenodesis screw (Arthrex Inc.) into the tunnel (Figure 3).

The final positon of the tunnels and the stability of the ankle joint is again tested under fluoroscopy.

The skin is closed with separate stitches. A sterile dressing and a back slap in 90° are applied.

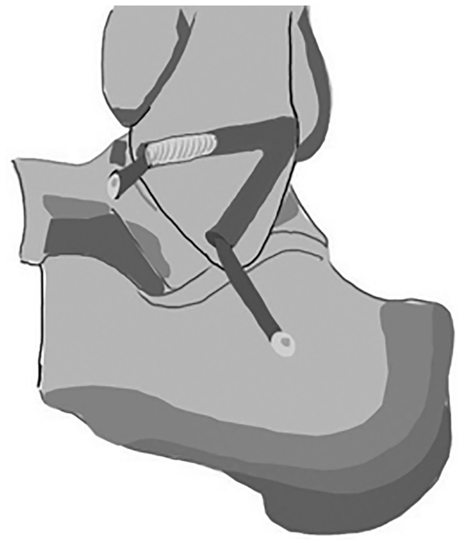

Figure 3. — Position of the bone tunnels and bio-tenodesis screws.

The post-operative regimen is mainly dictated by concomitant procedures.

If only a lateral ligament reconstruction is performed, patients are immobilized in a lower leg cast for 10-14 days, followed by a rehabilitation program with the focus on mobilization of the ankle joint.

RESULTS

Out of the 18 selected patients, 17 were available for follow-up.

One patient was lost to follow-up due to a move abroad.

Eighteen operations were assessed, one patient had surgery on both ankles.

The cohort comprises 9 (53%) male and 8 (47%) female patients, ranging in age from 17 to 59 years (mean 33).

Concomitant procedures were performed on 15 out of 18 ankles : resection of anterior bony or soft tissue impingement, chondroplasty for osteochondral defects, varus correction of the hindfoot, peroneal tendon reconstruction and removal of intra-articular loose bodies (table I).

The average post-operative AOFAS score was 90 points, ranging from 48 to 100 (median : 95).

Table I. — Descriptions of patients

No	Sex	Age	Concomitant procedure
1	M	26	AS + Ch
2	F	17	/
3	M	56	VCH
4	F	20	AS + Ch
5	M	59	VCH
6	F	43	AS + RAO + RIALB
7	M	28	AS + Ch + RAO + RIALB + VCH
8	F	30	AS + Ch
9	F	22	AS + RAO
10	M	45	Ch + AS + RAO + RIALB
11	F	58	/
12	M	33	AS + RAO + PTR
13	F	17	AS + Ch
14	M	21	VCH + AS
15	F	18	AS + Ch
16	M	20	AS + RAO
17	M	40	VCH

AS = anterior synovectomy, Ch = chondroplasty, RAO = resection of anterior osteophytes, VCH = varus correction of the hindfoot, RIALB = removal of intra-articular loose bodies, PTR = peroneal tendon reconstruction.

Satisfaction with the result of surgery was rated as excellent by 13 (76%), as good by 2 (12%) and as poor by 2 patients (12%).

The Karlsson Ankle Functional Score (KAFS) ranged from 37 to 100, with a mean score of 85 (median : 94).

The average VAS score was 1.2, ranging from 0 to 7 (median : 0.5).

When the patients were asked if they would still have this surgery again, 15 out of 17 patients responded they would, 2 answered they wouldn't.

None of the patients reported any discomfort at the hamstrings tendon harvesting site around the ipsilateral knee.

Thirteen out of 17 patients (76%) returned to the same pre-operative level of sports, one of them being a highly competitive gymnast. 3 patients (18%) reduced their level of activities and one patient (6%) wasn't able to play sports at all post-operatively.

Following complications were encountered post-operatively : 1 minor wound problem around the hamstrings tendon harvesting site, 1 patient suffered from a new traumatic inversion of the ankle and 1 patient reported residual episodes of giving way. This last patient was not able to return to his sport activities but did not ask for further surgery at the moment of the last follow up.

DISCUSSION

This study found 83% good to excellent clinical results following percutaneous stabilization of the LLC with a gracilis tendon autograft, after adjuvant arthroscopy of the ankle joint *(29)*.

Although the modified Broström procedure is still considered to be the golden standard for the treatment of symptomatic chronic lateral ankle instability, sometimes the quality of the torn ligaments just isn't adequate for primary suturing.

We chose to reconstruct the ligaments in an anatomical way to avoid restriction of subtalar mobility *(30,38)*.

The two-tunnel technique in the distal fibula, fixing a tendon graft with interference screws, was first published by Jung et al. in 2012 using an open procedure. They achieved stable tendon fixation with satisfactory clinical outcomes *(22)*.

In our study, we applied the same tunnel positioning to an arthroscopically assisted percutaneous procedure. In this way, we were able to assess intra-articular lesions and minimize the risk of wound problems.

Some authors prefer the use of a single bone tunnel in the distal fibula to eliminate the risk of fracture of the bone bridge between the two tunnels and subsequent fixation failure *(15,32)*. This never occurred in our case series.

In the past, the senior author (KB) tried to adopt the percutaneous technique of Glazebrook et al. which also uses a single bone tunnel in the distal fibula *(15)*, but found more breakout of the tendon graft out of the tunnel. This might be caused by the thickness of the Y-shaped graft.

So far however, no biomechanical studies have been published who recommend the use of a single or double bone tunnel in the distal fibula.

Although proven to be safe *(31)*, all-arthroscopic anatomical reconstruction techniques like that of Guillo et al. *(17)* seem to be technically more demanding than our arthroscopically assisted percutaneous technique.

We used autograft tendons because of the delayed graft-bone incorporation that is described with allograft tendons *(20)*.

Other drawbacks of the use of allograft tendons are an increased cost, subclinical immune responses and the (minimal) risk of infection transmission.

Hamstring weakness after autograft harvesting does not seem to be an issue as Tashiro et al described good recovery of knee flexion strength after harvesting both gracilis and semitendinosus tendons for use in ACL reconstruction *(37)*.

Advantages related to the use of an allograft tendon are a shorter operation time and the absence of donor-site morbidity. The hamstring tendons would also still be available for an eventual ACL reconstruction in the future.

Attention must be paid to diagnose and treat associated foot pathologies.

In our study, 78% of the chronic unstable ankles showed associated intra-articular lesions, predominantly anterior soft tissue impingement (12 out of 18 ankles).

It was demonstrated in 2013 by Kerr et al. that arthroscopic debridement of scar tissue in the chronic unstable ankle has positive effects on functional stability *(28)*.

Furthermore, Bonnel et al. stated that a decrease in dorsal flexion of the ankle is a factor contributing to ankle instability. Removal of anterior osteophytes and synovectomy for anterior impingement should therefore be part of the surgical treatment *(2)*.

However, the treatment of extra-articular foot pathologies can also be extremely important.

In our case series, we encountered 5 hindfoot varus deformities. Correcting this deformity by means of a realignment osteotomy of the hindfoot, lowers the stress on the newly reconstructed lateral ligaments. This may decrease the risk of laxity recurrence.

Limitations to this study include its' retrospective character, the lack of pre-operative data for comparison and the small number of included cases.

With a mean AOFAS score of 90 points, VAS score of 1.2 and KAFS score of 85, our outcome is comparable with the results of open anatomic reconstructive procedures *(8,10,19,22,32,34)*.

One patient had persisting lateral ankle instability, but was reluctant towards revision surgery.

Despite the small number of included cases, we believe that this arthroscopically assisted percutaneous technique is a viable treatment option for chronic lateral ankle instability.

It offers an alternative for the modified Broström procedure when tissue quality is poor and carries all the advantages of a minimally invasive procedure.

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