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Ligamentum teres reconstruction: indications, technique and minimum 1-year results in nine patients

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ABSTRACT

Ligamentum teres (LT) tear is a recognized cause of hip pain. Debridement of tears and capsule plication has shown satisfactory results. However, a group of patients with complete tears do not improve after debridement and physiotherapy. The purpose of this work was to describe the senior author's technique and clinical results for the early series of LT reconstructions. Retrospective analysis of prospectively collected data. Patients who underwent isolated LT reconstruction between 2013 and 2018. All the patients had previous debridement of a completely torn LT, capsule plication and rehabilitation. Patients who had any other associated procedure during LT reconstruction surgery and dysplastic acetabular features were excluded. Demographic and clinical data was reviewed. Complications, type of graft and modified Harris hip scores (mHHSs) were recorded preoperatively and at 1-year follow-up. Fifteen LT reconstructions were performed during the study period. Six were excluded (as they had additional procedures performed during surgery) and nine patients aged a mean 30 (range: 22–48) years old were included. The patients had a mean of 2 (range: 1–4) prior surgeries. At minimum 12 months (range: 12–24) 9/9 patients reported reduction of pain and instability symptoms with mHHSs of 84.2 (73.7–100) versus 51.7 (36.3–70.4) preoperatively ($P = 0.00094$). Three patients (of the total cohort of 15) underwent second-look arthroscopy (11–22 months after reconstruction). None of these patients underwent total hip replacement at a mean of 4 (range: 1–6) years. Arthroscopic LT reconstruction improved function and pain in patients with persistent pain and instability after resection of the LT.

INTRODUCTION

Ligamentum teres (LT) tear is a recognized cause of hip pain [1, 2]. From the anatomical perspective, it has been shown that the LT has a high density of free nerve endings and from the clinical perspective, there is up to a 51% of LT ruptures in patients undergoing hip arthroscopy, validating its potential role as a pain generator [3, 4]. The LT has been shown to participate in hip proprioception and as a secondary hip joint stabilizer, especially in positions combining abduction and flexion [5, 6]. The understanding of its contribution to hip biomechanics continues to evolve [2, 3, 7]. Its rupture has been related not only to traumatic instability but also to femoroacetabular impingement (FAI). A higher rate of LT tears has been recognized in patients with hip and/or generalized ligamentous laxity (GLL) [8, 9]. These patients tend to be female and present an increased range of motion of the hip, not necessarily associated with hip bone anatomy abnormalities [9, 10]. In those patients with GLL, the secondary stabilizer function of the LT becomes more important. As LT pathology is often present in conjunction with many other hip conditions (labral tears, FAI, chondral defects, etc.) and as the pain is not distinguishable from those lesions, some authors have attributed to LT tears the ongoing pain after all other recognized hip abnormalities have been treated [5].

Arthroscopic debridement of partial and complete tears, in combination with capsule plication when there is evidence of GLL, has shown generally satisfactory results [8, 11]. However, a group of patients with complete tears, remain symptomatic after debridement, complaining of pain and/or instability symptoms, such as pain when rising from a chair, or getting into and out of a car, as well as painful clicking or clunking [12]. This background of instability as a pain generator and the role of LT as a joint stabilizer guided the authors to propose that in these cases LT reconstruction might benefit hip stability and symptoms. This painful outcome is likely to be secondary to a combination of multiple factors; the lack of a functioning LT hip stabilizer, GLL and in some cases dysplastic features even not fulfilling criteria to be diagnosed as dysplastic hips. Some authors have called this convergence of conditions 'microinstability' [13–15]. The purpose of this study is to report the functional outcome using modified Harris hip score (mHHS) and complications in nine cases of arthroscopic LT reconstruction.

MATERIALS AND METHODS

All patients provided written consent for use of their data for audit (specific IRB consideration was not required).

This series includes patients who underwent arthroscopic LT reconstruction between March 2013 and February 2018. This is a retrospective analysis of a prospectively collected database including preoperative findings (timing and nature of the symptoms plus imaging findings) and scores (mHHS).

Inclusion criteria: Patients ≥18 years old with at least one previous arthroscopic hip surgery who remained symptomatic after excision of the completely torn LT remnants, along with capsule plication, plus at least 6 months of extensive rehabilitation were offered reconstruction. Symptoms considered for this study included groin or buttock pain, apprehension, psoas or iliotibial band (ITB) tightness, painful catching or 'giving-out' feeling.

Exclusion criteria: Patients who had any other associated procedure performed on the hip during the LT reconstruction (such as labral repair or reconstruction, or additional capsule plication), patients with acetabular dysplasia with a Lateral Center Edge Angle <25°, or an Acetabular Index (Tonnis Angle) >10°, and patients with missing clinical data or lost before completing 1-year follow-up.

A review of demographic and clinical data was done in the patients. Demographic data, including an assessment of GLL (Beighton Score) [16], traction times, type of graft, complications and mHHSs were recorded preoperatively and at follow-up. Complications, especially conversion to total hip arthroplasty were recorded for up to 6 years.

The difference between pre- and post-operative scores was analysed with a two-tailed Mann–Whitney test, setting as significant a P-value <0.05.

Operative technique

All the procedures were performed by the senior author in the lateral decubitus position, with increased hip abduction to improve access through the femoral drill hole to the acetabular fossa and slightly higher than usual countertraction post position to deliberately lift the femoral head laterally.

Three portals were routinely used; mid-trochanteric, anterior and posterior-paratrochanteric.

Routine diagnostic arthroscopy was performed first.

Preparing the acetabular surface: first, the posterior-peripheral LT footprint on the acetabular floor as far as the Transverse Acetabular Ligament is debrided (cleared) using radiofrequency and the bony surface of the fossa lightly burred to provide a raw, bleeding surface (Fig. 1). This may be best completed later by passing the burr down the drilled tunnel in the femoral neck and head (Fig. 2).

Through a small separate incision over the more distal part of the greater trochanter (GT), the entry point for the femoral tunnel is cleared. Using a specially modified guide, a guide wire is drilled through the GT, femoral neck and head, exiting through the femoral head fovea (Fig. 3).

The guide wire is located centrally in the neck in anteroposterior plane and deliberately started a little more

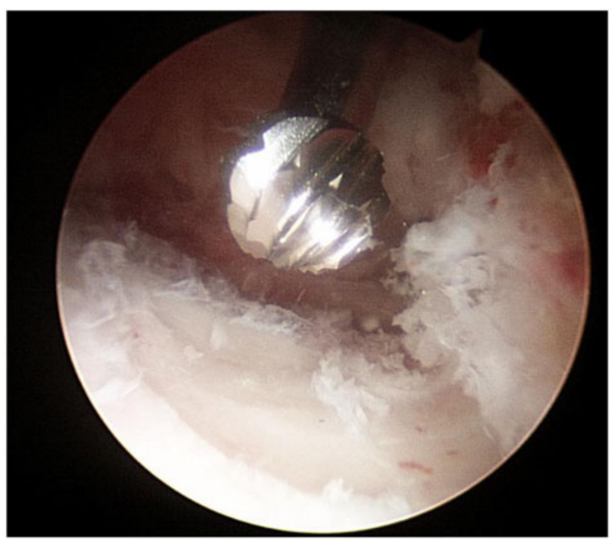

Fig. 1. Arthroscopic view of the LT footprint on the acetabular floor. The soft tissue and bony surface is debrided with a burr.

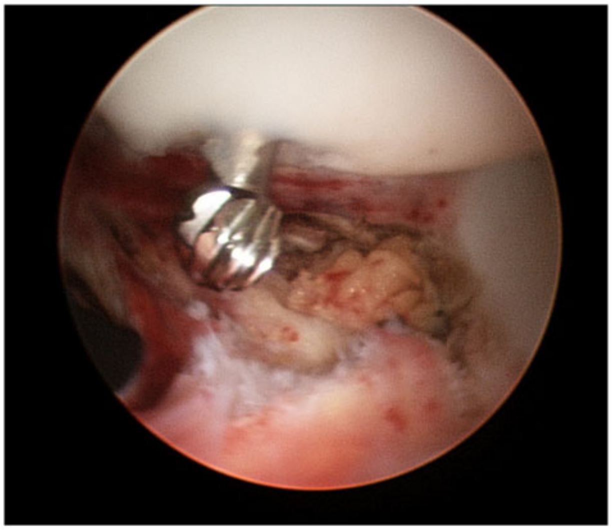

Fig. 2. Arthroscopic view of the LT footprint and burr through the femoral head–neck tunnel. Passing the burr through the tunnel helps debriding the bony surface of the footprint.

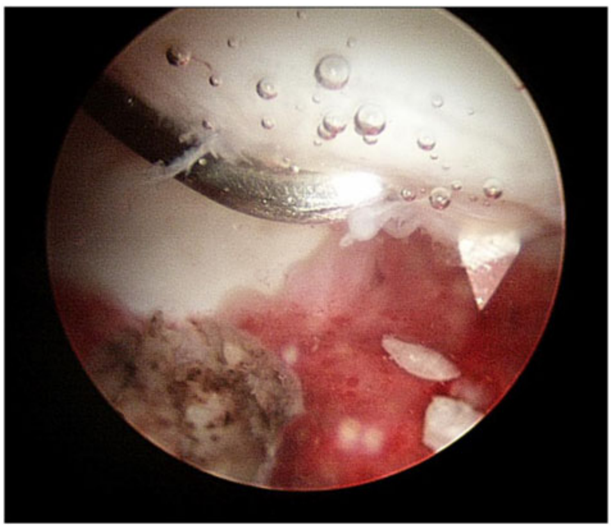

Fig. 3. Arthroscopic view of the drilling guide (modified version of an ACL drilling guide) and guidewire at the fovea in the femoral head.

proximally on the GT than would be the case for a hip fracture fixation screw. Again, this allows the tunnel to be flatter in the femoral neck, and then to be pointing more directly at the prepared acetabular fossa attachment area which is cleared using radiofrequency and a burr (Fig. 4).

Using a tibialis posterior tendon allograft as a doubled construct the graft typically measures 8–9 mm. A strong non-absorbable suture (Number 5 Ti-Cron, Medtronic, Minneapolis, MN, USA) is attached to the tail end of the graft using a Bunnell type stitch which is left long to later tension the graft. The tunnel is drilled 1 mm larger than the graft to facilitate graft passage.

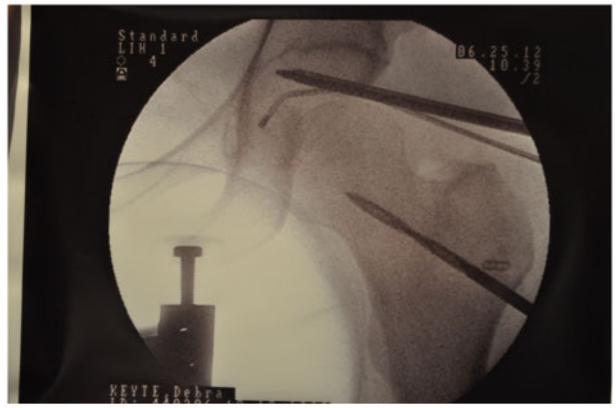

Fig. 4. Antero-posterior X-ray view of the hip with the drilling guide in place and drill advancing through the femoral neck to the femoral head fovea.

The acetabular fixation is performed with two 2.3 mm hip anchors (Osteoraptor, Smith & Nephew, London, UK) which are inserted via the femoral tunnel into the acetabular floor (Fig. 5). Femoral side fixation is performed later with an interference screw (RCI screw, Smith & Nephew, London, UK). One arm of each anchor stitch is passed through the loop end of the doubled graft, and the graft then introduced through the tunnel into the joint and the anchor sutures are tied using a knot pusher, also passed through the tunnel.

The hip is left in traction and externally rotated 40°. Using the Ti-Cron stitch the graft is tensioned firmly (no tensiometer was used) and then fixed in the femoral tunnel using a titanium interference screw (RCI; Smith & Nephew, Carlsbad, CA, USA). The screw is advanced under image intensifier control to be several millimetres short of the subchondral bone of the femoral head.

The functional integrity of the graft was assessed during arthroscopy by rotating the hip into full internal and external rotation. An assessment was made regarding whether the graft was seen to tighten and the femoral head remain deep in the acetabulum. Also, a visual check was made that the acetabular attachment of the graft was maintained and there was no graft separation from the bone. When the LT is present and functional, the femoral head is seen to be maintained centrally within the acetabulum. When the LT is completely torn, we have observed that in external rotation, the femoral head translates anteriorly and may ride up over the anterior edge of the acetabulum and labrum.

RESULTS

Fifteen LT reconstructions were performed during the study period, six were excluded (due to concomitant labral

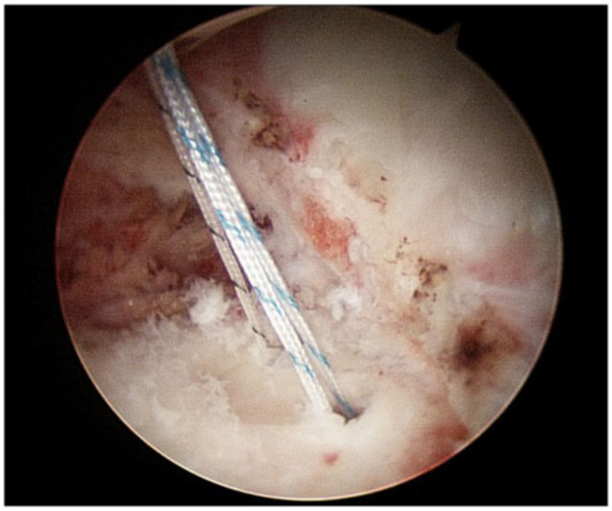

Fig. 5. Arthroscopic view of the LT footprint with two anchors in place.

repairs and microfractures) and nine patients (nine hips), with a mean age of 30 (range: 22–48) years old were included (Table I). There were no excluded patients due to missing clinical data, and none lost to follow-up. Full pre- and postoperative data was available for all patients. All were women, and all had at least subtle GLL with a mean Beighton Score of 7 points (range: 5–9). The patients had a mean of 2 (range: 1–4) previous surgeries and 4 years (range: 2–7) of symptoms. Autologous semitendinosus tendons (in the first five patients) and Tibialis posterior allografts (in the last four patients) were used as grafts (Table II). All the grafts were tested intraoperatively and proved to maintain the femoral head in concentric position in the acetabulum in maximal external and internal rotation.

One of the 15 patients required revision due to graft reabsorption of a previously performed reconstruction (primary reconstruction is not included in this series). The revision procedure has been included.

The average traction time was 74 min (range: 60–101) (Table II).

Complications reported included only one patient presenting labial blisters (88 min of traction) that resolved spontaneously approximately 4 weeks after the procedure.

At a minimum of 12 months (12–24) all patients reported reduction of pain and instability symptoms with better mHHSs of 86.9 (73.7–100) versus 51.15 (36.3–70.4) preoperatively ($P = 0.00094$).

Three patients underwent second-look arthroscopies at their request (Fig. 6). All had only mild recurrent or persisting symptoms (11, 13 and 24 months after LT reconstruction), but the patients preferred to fully assess the

Table I. Patients demographic data

Age (years), median (range)	*30 (22–48)*
Gender	
Female	9/9
BMI (kg/m^2), median (range)	25 (18.4–31.2)
Duration of symptoms (years), median (range)	4 (2–7)
Prior surgeries	2 (1–4)

BMI, body mass index.

integrity of their reconstructions. As there are not yet any validated MRI means for assessing LT graft integrity, this assessment can only be done by arthroscopy. All grafts were assessed to be fully functional. In one case a partial tear was recognized and debrided. In 1 case in which the major complaint was a feeling of mild, persisting instability, the capsule was re-tightened. There was no need for revision of the grafts.

None of these patients underwent total hip replacement at an average of 4 years (range: 1–6 years) after the reconstruction of the LT.

All patients expressed satisfaction with the procedure, and stated that they would recommend the procedure.

DISCUSSION

This study shows a significant improvement in the pain and function (measured by mHHS) of a particularly difficult group of patients with several prior procedures and long-standing symptoms.

Outcomes recorded after a minimum 1 year of follow-up showed a clinically significant improvement in function (measured using the mHHS), with 8/9 patients reaching the patient acceptable symptomatic state, as previously determined for FAI surgery [17]. It is reassuring to report that none of the patients in this series underwent hip replacement surgery 4 years (range: 1–6) after the LT reconstruction surgery.

This series represents a significant addition of information to a technique which is continuing to develop, with only 11 cases reported to our knowledge to date.

The function of the LT is becoming better understood and its importance as a potential generator of hip symptoms is getting attention [11]. The role as a secondary stabilizer and its importance in patients with otherwise borderline stability (dysplastic features, generalized laxity, iatrogenic capsular defects) is gaining wider acceptance

Table II. Detailed clinical data for each case

Patient number	*Age*	*BMI*	*Number prior surgeries*	*Graft type*	*Traction time*	*Second look*	*Baseline mHHS*	*mHHS at 1-year follow-up*
1	22	31.2	2	Alo	88	1	36.3	79.2
2	28	23.3	2	Alo	101	0	40.7	95.7
3	22	30.5	1	Alo	74	0	52.8	97.9
4	29	23.5	4	Auto	65	1	52.8	81.4
5	48	26.8	4	Auto	63	1	51.7	86.9
6	31	23.0	2	Alo	64	0	70.4	100
7	30	18.4	3	Auto	81	0	47.3	73.7
8	45	29.0	2	Auto	80	0	51.7	100
9	32	25.0	3	Auto	60	0	50.6	79.2

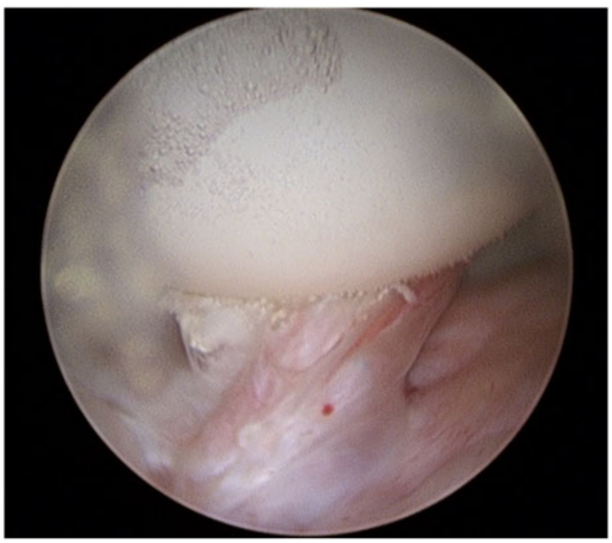

Fig. 6. Arthroscopic view of second look to an LT reconstruction performed 11 months before, with semitendinosus muscle tendon autograft. The graft appears to be intact and functional.

[18]. In the presence and adequate function of the capsular structures the function of the LT seems to be of minor importance, although under the circumstances in which they fail to provide stability, the LT becomes relevant [19]. As reported by Martin *et al.* [13], the LT is tight in flexion and external rotation which in cases of a deficient anterior wall or lack of competent capsule might be of increased importance.

Most patients who have had open FAI surgery and of necessity have had their LT transected, have no symptoms, but some have mild symptoms and good functionality scores and do not have any indication to reconstruct the LT. As reported by Phillips *et al.* [20] patients after surgical dislocation of the hip had non-arthritic hip scores (NAHS) of 80 (26–100) which represents good to excellent outcomes in the majority, although not all patients. The authors concur in the difficulty analysing the importance of the LT in the remaining symptoms as the pain and instability are rather non-specific and can be attributed to other concomitant hip pathologies.

Debridement of the LT has shown good results and is currently the treatment of choice in most cases [8, 11], as recommended by Philippon *et al.* [21] It is the small subset of high demand patients with instability of the hip who are refractory to standard arthroscopic management and rehabilitation that may require an LT reconstruction [22], or as proposed by Lindner *et al.* [23] patients with complete tears of the LT, subjective hip instability and presenting increased external rotation.

Available reports on LT reconstruction are two case series (four cases each) and three case reports. Simpson *et al.* [22] reported their first clinical case after testing and developing the concept in 12 cadaveric specimens. One difference to be noted in the reported technique is the acetabular fixation was obtained with an EndoButton instead of anchors. Amenabar and O'Donnell [24] reported the first case done with the initial technique used by the senior author and modified after the first case as described in this article. Philippon reported the first clinical series including four patients in arthroscopic LT reconstruction was performed using ITB autograft [22]. Encouraging results were reported with two patients improving symptoms and the third one with excellent follow-up scores but no baseline score to compare. The fourth patient despite presenting better mHHSs at 1 year underwent total hip replacement between 1 and 2 years after the LT reconstruction. That patient had not only dysplastic features which might have influenced the unsuccessful outcome and represented an exclusion criterion for our study, but also presented advanced degenerative changes.

Hammarstedt *et al.* [25] reported the case of an LT reconstruction in an Ehlers–Danlos patient complaining of hip instability with satisfactory 1-year results including the NAHS increasing from 27.5 to 50 and visual analogue scale pain scores decreasing from 8 to 0.

Chandrasekaran *et al.* [26] reported four LT reconstructions in three patients with connective tissue disorders and GLL. At a mean follow-up of 21.4 months, three of the four procedures presented improved patient-reported outcomes.

This group of patients demonstrates that in the presence of GLL, LT deficiency, even after capsule plication and muscle rehabilitation, may be associated with persisting symptoms of pain and instability. They also demonstrate that LT reconstruction may lead to marked improvements in these symptoms.

The initial autograft choice of hamstrings as opposed to the ITB used by Philippon was due to the similarities of the LT and anterior cruciate ligament (ACL) structure which has been noted previously and the higher stress that the LT has to tolerate and reports of high failure rate of ITB autografts in ACL reconstruction of female patients [3, 19]. Later in the series, as a result of frequently finding the hamstring tendons (Semitendinosus ± Gracilis) in these patients were very small and inadequate, allograft use was initiated. Allografts provide predictably sized grafts and significantly decreased donor site morbidity. There have not yet been any observed allograft failures.

The strengths of this study include a larger number of patients, with 100% follow-up, and the first presentation of the results of three second-look arthroscopies. These arthroscopies demonstrated the presence of functioning and intact or nearly intact grafts. All nine patients had only LT reconstructions done during the analysed procedure, eliminating the confounding effect of labral reconstructions and or microfractures.

Several limitations of this study should also be disclosed. There are still only a small number of patients, all female, with no control group and the follow-up remains relatively short. Outcomes were documented using only the mHHS which has been criticized in hip arthroscopy patients due to a ceiling effect. It would have enhanced the quality of the information obtained from these cases to include other scores used frequently in current literature, such as the hip outcome score or the International Hip Outcome Tool iHOT [27, 28]. Changing the type of graft used might also influence the results. As this procedure has only been indicated after other surgical techniques have failed to provide relief, it is difficult to obtain a homogeneous group of patients. Each patient in this series had two to four prior procedures performed with different techniques and by different surgeons. Another limitation of our work and the current knowledge of the technique is that the LT reconstructions were tested only in terms of femoral head translation at maximal external and internal rotation. The maximal resistance in tension has not been tested in these patients.

The authors have regarded the technique of LT reconstruction as still experimental, and evolving. Therefore, the procedure was offered only to a small group of patients with the most significant symptoms, and these patients were then carefully followed. The modification in the graft choice reflects the surgeon's preference over time and might cause some differences in outcomes, although none were observed in this study group. These early results allow some increased confidence that LT reconstruction has a role in the treatment of this carefully selected group of patients suffering from pain and instability after complete LT tear, when they have not had adequate improvement following arthroscopic LT debridement and capsule plication.

CONCLUSIONS

Arthroscopic LT reconstruction offers improvement in function and pain to patients with persistent pain and instability after resection of a torn LT.

CONFLICT OF INTEREST STATEMENT

None declared.

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