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Review article

A novel and simple classification for ligamentum teres pathology based on joint hypermobility

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ABSTRACT

Ligamentum teres (LT) pathology (including synovitis, partial and complete tears) is common at the time of hip arthroscopy with a reported prevalence of 51–90%. Currently, there are four published classifications of LT injuries and tears. The majority focuses on differentiating partial from full thickness tears, whereas a more recently published classification also incorporates the presumed underlying mechanism of pathology. A recent review of the current classification systems found that all are deficient for lack of inclusion of what constitutes a normal ligament, lack of inclusion of synovitis as a source of pathology and lack of inclusion of hypermobility as part of the treatment algorithm. Also, the two most commonly used classification systems have only fair inter-observer reliability. Recent work has found that underlying joint hypermobility plays an important role in LT pathology and that the addition of capsular plication/suture at the time of surgery for LT pathology improves outcomes and reduces re-tear rates. In order to address these problems which have been identified with the currently available classification systems, we propose a novel and simple classification for LT pathology based on underlying joint hypermobility [as assessed by the Beighton test score (BTS)]. LT pathology is used to divide all patients into four types: 0 normal (which includes minor fraying), 1 synovitis (which would also include minor fraying), 2 partial tear and 3 complete tear. Further, all types are subdivided into two groups: Group A patients have no clinical evidence of joint hypermobility (BTS < 3), whereas Group B patients do have clinical evidence of joint hypermobility (BTS ≥ 4). On the basis of this classification system and the available literature, we have also developed a treatment algorithm for LT pathology.

INTRODUCTION

Role of the ligamentum teres

The ligamentum teres (LT) and its role in hip function has been controversial since Professor W.S. Savory's presentation to the Cambridge Philosophical Society in April 1874 on its function [1]. The LT assumes an important role in the neonatal hip as a stabilizing structure and a conduit for the blood supply of the femoral head [2, 3]. However, traditional orthopaedic teaching has been to regard the LT as a redundant or vestigial structure in the adult hip. With the advent of hip arthroscopy in the last few decades there has been renewed interest in the role of LT in hip pathology and hip motion [4]. Our understanding of the role of the LT in the adult hip [4, 5] has evolved. The LT is now believed to act as a secondary stabilizer to supplement the capsular ligaments and works in a sling like manner to prevent subluxation of the femoral head at the extremes of motion [6–9]. Further, it probably has a role in nociception [10, 11], and less defined role in proprioception [10] and synovial fluid lubrication [12].

Prevalence of LT pathology

LT pathology (including synovitis, partial and complete tears) is commonly observed at the time of hip arthroscopy with a quoted prevalence of up to 51–90% [12–14]. Further, it has been suggested that lesions involving the LT are the third most common cause of hip pain in athletes undergoing diagnostic arthroscopic procedures [15]. Less than 2% of LT tears are diagnosed on preoperative magnetic resonance imaging and magnetic resonance

arthrography (MRA) scan [15]. There have been recent reports of improved accuracy using MRA, and traction MRA [16, 17, 18 Act], but hip arthroscopy remains the gold standard for the diagnosis of LT pathology [19]. Most current classification systems focus only on tears [12, 13], which make up roughly half of the pathology to the LT [14], the other half being synovitis alone. Fraying of the LT is not typically reported in any classification or descriptive study.

LT and joint hypermobility

As our understanding of the LT has evolved so has its association with benign joint hypermobility and the impact on treatment. Benign joint hypermobility, has been shown to be associated with an increased incidence of LT tears [20]. It has been hypothesized that the capsular laxity in such patients may allow over-stretching and tearing of the LT, typically from its femoral attachment. It has also been suggested that the LT may assume a more important role as a stabilizer of the hip when the capsular ligaments are lax [7].

The Beighton test score (BTS) is the accepted clinical standard for determining joint hypermobility in children and adults [21–23]. The BTS, consisting of five clinical manoeuvres, is scored dichotomously (0/1) from which a total score ranging from 0 to 9 is calculated [23]; with a BTS score of 4 or more being widely accepted as the clinical definition of joint hypermobility [21, 24]. A BTS of 4 or more has been shown to be associated with a reduced capsular thickness and with a high prevalence of partial tears of the LT [20]. Further, capsular laxity (thinning) alone is associated with a higher incidence of LT pathology [25].

In patients with complete LT tears who have generalized hypermobility, reconstruction of the LT, combined with capsule plication, has improved patient related outcome measures [26, 27]. Improved hip stability obtained by routine anterior capsular tightening, using either radiofrequency energy (RF) or suture plication, also leads to significant improvement in results for patients having partial LT tear debridements [28]. This method has resulted in a lesser re-tear rate than LT debridement alone [29].

Current classification systems

Currently there exist four arthroscopic classifications for LT injuries and tears, and they can be summarized as follows. Gray and Villar (1997) [12] proposed the first classification: Type I complete tear; Type II partial thickness tear; and, Type III tear associated with degenerative changes. Botser and Domb (2011) proposed a more descriptive classification by dividing partial tears into two groups: Group I included a partial tear visualized to be <50% (low grade); Group II a partial tear of >50% (high grade); and Group III full thickness tear [13]. Cerezal *et al.* (2010) [30] built on the earlier classifications of Gary and Villar by adding an avulsion fracture and absence of the LT. Salas and O'Donnell (2015) [31] proposed a more detailed classification by describing possible pathological causes, and potential treatments. The Gray and Villar classification continues to be the most widely used.

Need for a new classification system

An effective classification system must be valid, reliable and reproducible, but it should also standardize a language for consistent communication, provide guidelines for appropriate treatment, and aim to provide a reliable prognostic indication for the pathology [32]. It should also aim to provide a mechanism for evaluating and comparing treatment results across centers and institutions.

To date, there has only been one study [14] of the inter-observer and intra-observer reliability of the classification of LT tears using the two most commonly applied classification systems (Gray and Villar, and Botser and Domb), and it found only fair reliability of both. The major flaws identified in these two frequently used systems were:

i. Differentiation between normal LT and low grade or partial tears was a common source of reviewer disagreement.
ii. Synovitis was commonly identified as a potential source of pain in the absence of any discrete LT tear, but could not be included in either classification system.
iii. There is no definition of a normal LT, meaning that even very minor tears, of uncertain clinical significance, would be included as partial thickness tears. This may, in part, explain the claimed rate of LT tears identified at hip arthroscopy of up to 90% [33].

The importance of synovitis of the LT as a source of pain within the hip, with or without an associated partial thickness tear, is also evidenced by the report of the LT test [34] (Fig. 1). The test was shown to be positive with synovitis of the LT. Furthermore, synovectomy of the LT to treat synovitis without tear has been shown to be beneficial [31].

To address these identified flaws in the currently available systems, we propose a new classification system. Specifically, this classification includes a Normal Group to allow for very minor abnormalities, and a Synovitis Group so that patients with LT synovitis alone can be included. Further, partial thickness tears have not been sub-classified

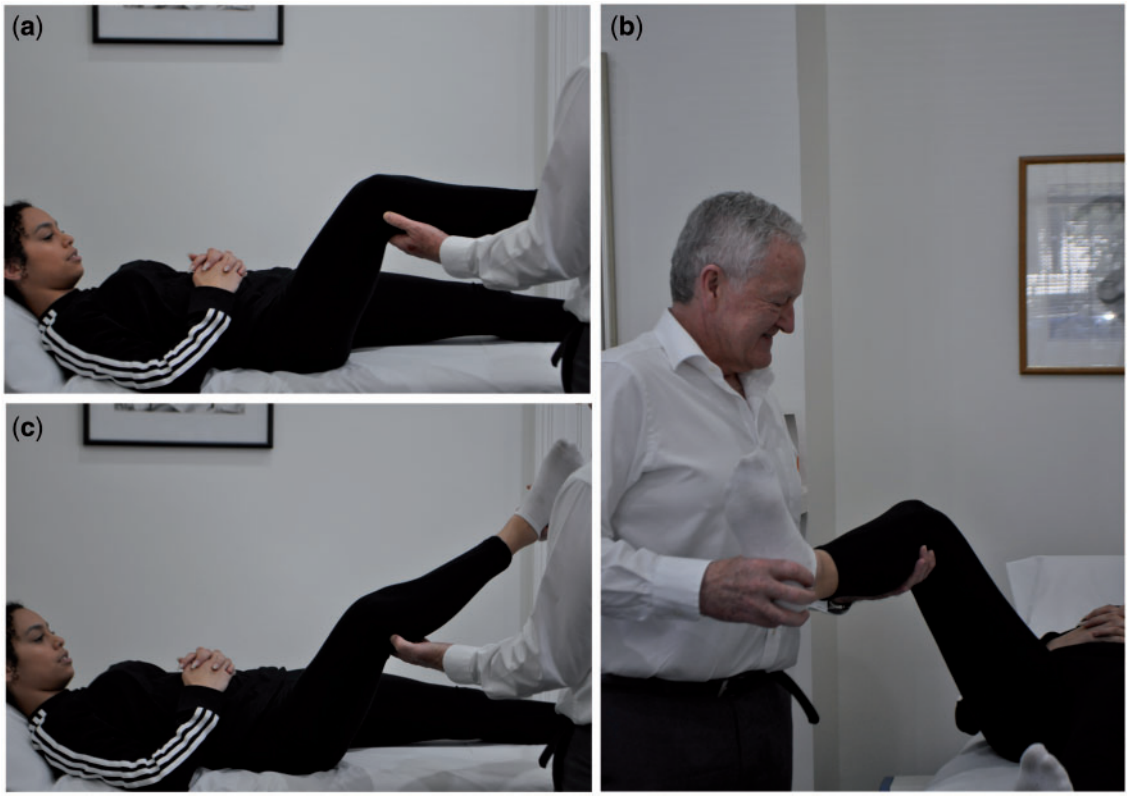

Fig. 1. Clinical image of the LT test. The LT test is performed with the patient in the supine position and the examiner standing next to the patient on the side of the examined hip. The patient's knee is flexed to 90 and the hip flexed to 70 **(a)** without tilting the pelvis. From this position, the hip is then abducted as far as the patient will tolerate. The hip is then adducted until it is 30 short of full abduction **(b)**. The hip is then fully internally and externally rotated until a firm end point is observed by the examiner. Internal and external rotation are performed in a smooth, steady manner **(c)**. We attempt to avoid causing undue pain in the patient by not pushing them past their pain tolerance. Pain provocation in either internal or external rotation is considered a positive test result. If pain is produced early in internal or external rotation before reaching a firm end point, then the test result is considered to be positive in that direction. The production of pain should be relieved with rotation in the opposite direction and reproducible with rotation in the direction of pain again.

into low and high grade, as these gradings have not been shown to lead to differences in symptoms, differences in treatment or difference in treatment outcome.

In addition, this classification takes into account the important added feature of any associated joint hypermobility. As noted earlier, treatment of hypermobility in addition to the treatment of the LT tears has been shown to result in improved outcomes.

Our proposed classification

All patients can be divided into four types (Table I) based on LT pathology found at the time of arthroscopy: Type 0 have a normal LT which includes any minor fraying (Fig. 2); Type 1 have synovitis, with or without minor fraying (Fig. 3), but without any evidence of tear including on dynamic testing intra-operatively (internal and external rotation of the hip; and dynamic intra-operative flexion); Type 2 have partial tears of the LT with or without evidence of synovitis (Fig. 4); and Type 3 have complete tears of the LT with or without evidence of synovitis (Fig. 5). All types are further subdivided into two groups based on absence or presence of generalized joint hypermobility as determined by the BTS—Group A consists of patients defined as not having clinical evidence of generalized laxity with a BTS of 3 or less; and Group B consists of patients with clinical evidence of joint hypermobility with a BTS greater than or equal to 4. Type 0 patients have not been subdivided into A or B as this does not change their management. In addition to clinical evidence, the surgeon can use excessive joint distraction on the intra-operative fluoroscan to confirm evidence of laxity (Fig. 6).

There is a general lack of consensus as to what constitutes a normal LT however we have included in Type 0 all patients that had a normal appearing LT or those with

Table I. Our proposed classification system for LT pathology according to group and type

		Group	
		A (no generalized laxity; BTS < 3)	*B (generalized laxity; BTS ≥ 4)*
Type	0 Normal (including minor frayed)	0	0
	1 Synovitis (± fraying)	1A	1B
	2 Partial tear (± synovitis)	2A	2B
	3 Complete tear (± synovitis)	3A	3B

BTS, Beighton test score.

Fig. 2. Normal LT demonstrating the double bundle pattern—Type 0.

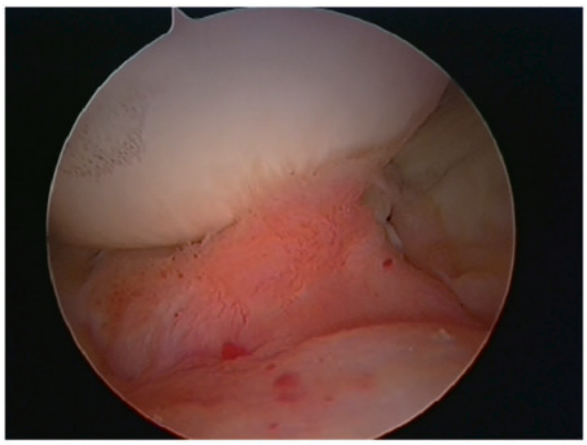

Fig. 3. Synovitis and mild fraying of the LT—Type 1.

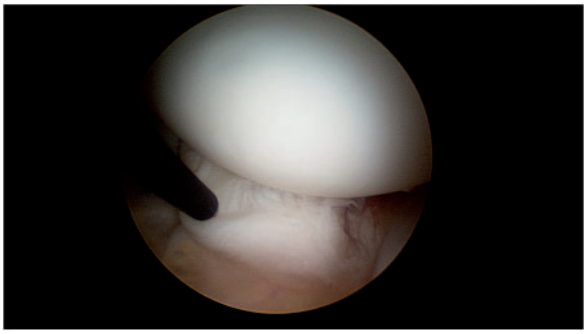

Fig. 4. Partial tear of the LT with mild fraying—Type 2.

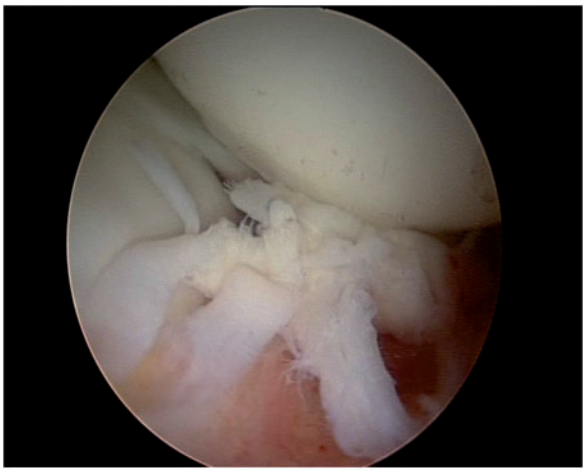

Fig. 5. Complete tear of the LT with fraying—Type 3.

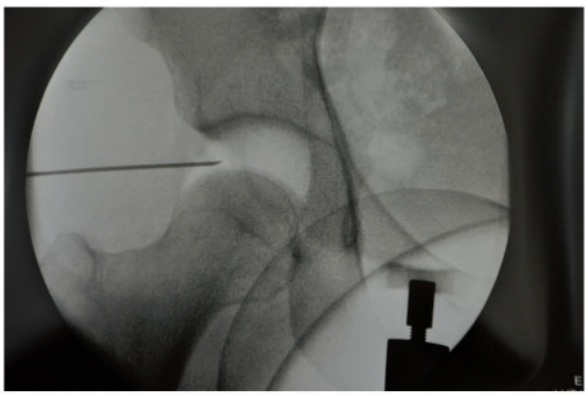

Fig. 6. Intra-operative fluoroscan of excessive joint distension in a hypermobility patient.

only minor fraying but without any evidence of synovitis or tears. Additionally, there is a subset of patients with less common pathology of the LT (such as impingement against the articular cartilage and focal hyperemia of the acetabular surface [31]) which have not been included in the current classification system due to the need to balance

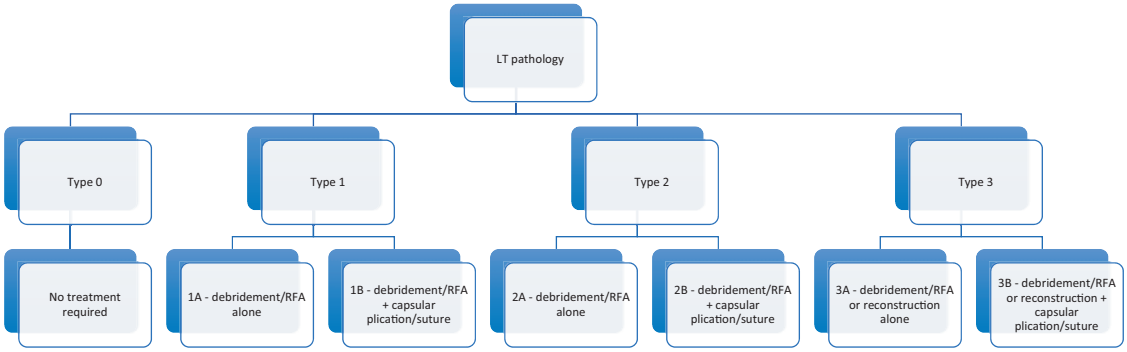

Fig. 7. Treatment algorithm based on our proposed classification system and available literature (LT, Ligamentum teres; RFA, radiofrequency ablation).

a simple classification system against the need for inclusion of all probabilities of low frequency, but these can be broadly grouped under Type 1 as their treatment is similar to that of LT synovitis.

LT tears have been shown to occur in association with several bony abnormalities [4, 35, 36], most particularly acetabular dysplasia, and femoroacetabular impingement, but also hypoplastic antero-inferior horn of the acetabulum, increased femoral anteversion, and femoral retroversion. These bony anomalies have deliberately not been included in this classification for a number of reasons., but most particularly because each of these would be treated on its merits irrespective of any associated LT tear. For example, a dysplastic acetabulum might be treated by peri-acetabular Osteotomy, and it is unlikely that the status of the LT would be considered in this decision making process.

The classification is intended to take into account soft tissue factors relating to the severity, and treatment of LT tears. It is not intended to be a classification of all causes of hip instability. In addition, any attempt to include all bony anomalies or soft tissue factors in this classification system would inevitably greatly complicate the new classification, and our principal aims for the system include simplicity and ease of use.

Treatment algorithm

Our treatment protocol (Fig. 7) is based on the available literature. A recent systematic review of LT tears found that for partial tears arthroscopic debridement or radiofrequency ablation (RFA) remains the currently accepted standard in providing short term relief whereas for full thickness tears reconstruction, preferably, or debridement/RFA are the main options [37]. This is in concordance with the work of our group where we have found that arthroscopic debridement alone for LT tears results in short term relief in 80% of patients [29]. More recently [38–41] several authors have reported that arthroscopic reconstruction offers a viable option for the treatment of complete tears of the LT with good results.

In the group of patients with hypermobility and LT tears, the addition of capsular plication for such patients (although they represented a subset of the total group) reduces the re-tear rate [28]. For patients with capsular laxity, reconstruction with the addition of capsular plication has had good results [26, 27].

CONCLUSION

Current classification systems for LT pathology are deficient across three broad domains: lack of inclusion of normal; lack of inclusion of synovitis as a source of pathology; and lack of inclusion of hypermobility in the treatment algorithm. Based on these inherent deficiencies in the current classification systems, we present a novel and simple classification for patients with LT pathology (normal/frayed, synovitis, partial tears and complete tears) based on underlying joint hypermobility. We also present a treatment algorithm for all LT pathology based on the current available evidence from the literature.

CONFLICT OF INTEREST STATEMENT

None declared.

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