Ligamentum Teres Tears and Femoroacetabular Impingement: Prevalence and Preoperative Findings

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Purpose: To determine prevalence of ligamentum teres (LT) injuries identified during hip arthroscopy for treatment of femoroacetabular impingement (FAI) and to identify physical examination findings or radiographic characteristics specific to patients with complete LT tears that could possibly assist in a preoperative diagnosis. **Methods:** Between October 2006 and June 2015, prospective data were collected on consecutive hip arthroscopies. Inclusion criterion was primary hip arthroscopy in patients aged 18 years or older. All patients in the study were treated for chondrolabral dysfunction associated with FAI. Patients with prior hip surgery were excluded. A total of 2,213 out of 3,158 hip arthroscopies met the inclusion criterion. **Results:** Of the 2,213 hips, 233 (11%) had a normal LT, 1,947 (88%) had frayed/partially torn, and 33 (1.5%) had a torn LT. A higher prevalence of torn LT was seen in female subjects. Patients with torn LT had lower body mass index (BMI) (22.5 *v* 24.7; $P < .01$) than those with hips with normal LT. On radiographs, patients with torn LTs had a lower center edge angle and had increased odds of having a center edge angle less than 25°. Isolated cam or isolated pincer were seen more often in hips with torn LT than in hips with normal LT. Hips with torn LT were 3.1 times more likely to have a chondral defect on the femoral head than were hips with normal LT (95% confidence interval [CI], 1.2-8.7) and were 3.6 times more likely to have capsular laxity diagnosed at hip arthroscopy than were hips with normal LT (95% CI, 1.4-9.4). **Conclusions:** Among patients with FAI and labral pathology, complete tears of the LT were rare and were more likely to be seen in women and those with lower BMI and low center edge angles at arthroscopy. LT tears were associated with hip laxity and chondral defects of the femoral head. **Level of Evidence:** Level IV, prognostic case series.

Once considered a vestigial structure within the adult hip,[1] the ligamentum teres (LT) has recently become the subject of increased attention as a result of its role in hip stability and as a potential pain generator.[2,3] The LT is a powerful secondary static stabilizer of the hip joint in extremes of motion. It is normally taut in flexion, adduction, and external rotation.[4] On average, the mean length of the ligament varies between 30 and 35 mm and has a pyramidal shape.[4]

Recent literature has revealed that tears of the LT are associated not only with traumatic events but with other intra-articular pathologies, such as femoroacetabular impingement (FAI), osteoarthritis, synovial chondromatosis, osteonecrosis, and hip dysplasia.[5-9]

Diagnosing LT tears can be challenging because physical examination maneuvers and imaging methods are not as specific as with other intra-articular pathologies such as FAI. Therefore, it remains imperative to maintain a high degree of clinical suspicion to identify damage to the ligament preoperatively. The prevalence of LT tears in the presence of FAI has yet to be determined.

The purpose of this study was (1) to determine prevalence of LT injuries identified during hip arthroscopy for the treatment of FAI and (2) to identify physical examination findings or radiographic characteristics specific to patients with complete LT tears that could possibly assist in a preoperative diagnosis. We hypothesized that a higher prevalence of LT injuries in hips with FAI would be found than previously reported

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The authors report the following potential conflict of interest or source of funding: P.G. receives support from Smith & Nephew, Ossur, Siemens, and Vail Valley Medical Center. K.K.B. receives support from Smith & Nephew, Ossur, Siemens, and Vail Valley Medical Center. M.J.P. receives support from Smith & Nephew, Ossur, Siemens, Vail Valley Medical Center, Arthrosurface, DonJoy, Slack, Elsevier, Linvatec, HIPCO, and MIS. Research support has been provided to the institution by Smith & Nephew, Siemens, Ossur, and Arthrex.

Received July 17, 2015; accepted January 21, 2016.

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0749-8063/15671/$36.00

http://dx.doi.org/10.1016/j.arthro.2016.01.045

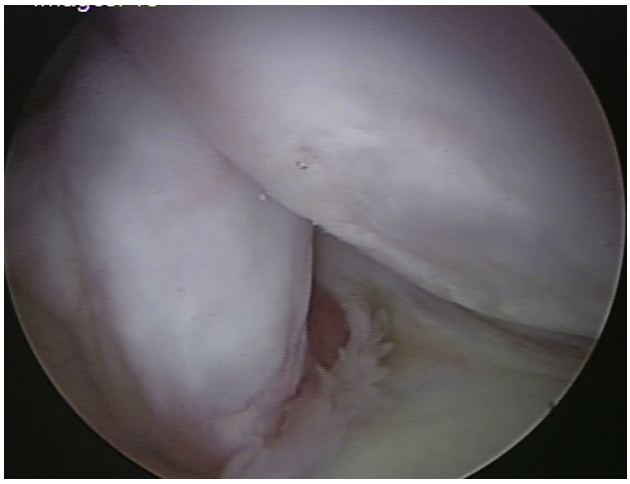

Fig 1. A normal ligamentum teres as seen at arthroscopy in the central compartment, using a 70° arthroscope. The ligament is probed to determine if an endpoint exists and there is limited elongation.

and that factors associated with LT tears in hips with FAI could be identified.

Methods

Between October 2006 and June 2015, a total of 3,158 hip arthroscopies were performed. Prospective data were collected to assess preoperative findings (physical examination and radiographic measurements) on hips that had either an intact or completely torn LT, which was classified at the time of visual inspection during hip arthroscopy. This study included primary hip arthroscopies in patients aged 18 years or older. All patients in the study were treated for chondrolabral dysfunction associated with FAI. Patients younger than 18 years and patients with prior hip surgery were excluded.

Physical examination data included range of motion (measured using a handheld goniometer), impingement test, hip dial, and Flexion Abduction and External Rotation (FABER) tests. Radiographic measurements included joint space width, weightbearing surface angle (Tönnis angle), center edge angle, Sharp angle, and alpha angle. All physical and radiographic examinations were performed within 1 month before surgery (range: 0 to 29 days).

All arthroscopies were performed by a single surgeon (M.J.P.) with the patient in the modified supine position, using 2 portals (anterolateral and mid-anterior).[10] The operative leg was placed at 30° of internal rotation to bring the femoral neck parallel to the floor. A standard diagnostic inspection was performed using a 70° arthroscope. During the central compartment inspection, the LT was visually inspected during all arthroscopies with the operative leg under traction. The LT was probed using a hooked probe or flexible probe and it was determined if there were any frayed or torn fibers. In each case, the LT was listed as normal when the LT was probed and both ends were attached and no torn fibers (Fig 1), elongation, fraying, loose fibers, and partial tears were grouped into frayed/partially torn (Fig 2), completely torn based on free movement of one end of the LT with probing (Fig 3).

Odds ratios were calculated using standard formulae. Data were tested for normal distribution using the Kolmogorov-Smirnov Z test. Comparisons of 2 categorical data were made using χ^2. For comparison of continuous variables, nonparametric univariate analyses were performed with the Mann-Whitney U test for comparison of 2 groups. Statistical analysis was performed using SPSS (version 18, SPSS, Chicago, IL) software package. All reported P values are 2-tailed, with an alpha level of 0.05 indicating significance. Post hoc power analysis was performed using G*Power (version 3.1.2; Franz Faul, Universitat Kiel, Germany).

Results

A total of 2,213 primary hip arthroscopies met the inclusion criterion (Fig 4). Of those, 233 (11%) had a normal LT, 1,947 (88%) had frayed/partially torn, and 33 (1.5%) had a completely torn LT. For this study, comparisons were made between normal and torn LTs. Demographics for the normal and torn groups are shown in Table 1. Women were 3 times more likely to have a torn LT than men (95% confidence interval [CI], 1.3-7.1). Significantly lower body mass index (BMI) was seen in patients with torn LT.

On radiographic examination, there were no differences in groups between joint space or alpha angle. Patients with torn LT had a higher Tönnis angle and were 5.1 times more likely to have a center edge angle

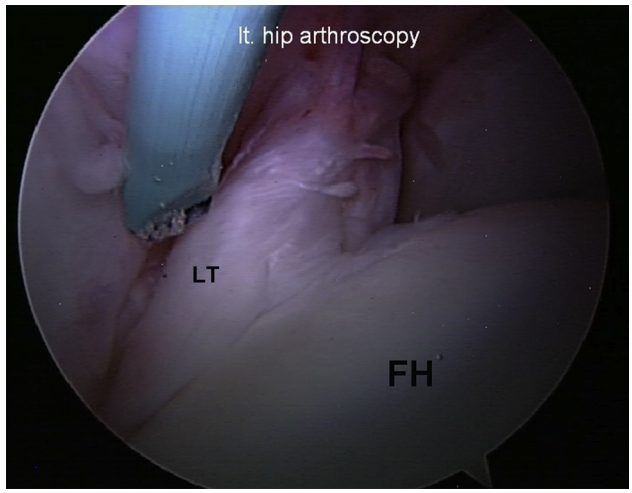

Fig 2. A frayed/partially torn ligamentum teres as seen at arthroscopy in the central compartment. Torn fibers are shown. (FH, femoral head; LT, ligamentum teres.)

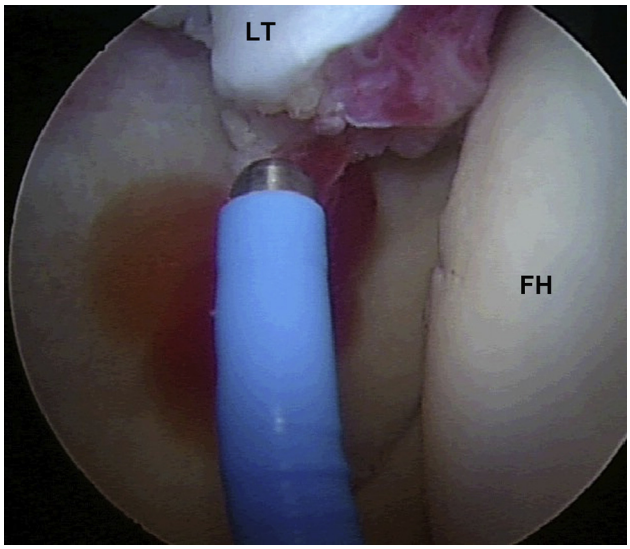

Fig 3. Completely torn ligamentum teres. The detached ligamentum teres is displaced in the joint from its native location. (FH, femoral head; LT, ligamentum teres.)

less than 25° than did hips with normal LT (95% CI, 1.8-13.9; Table 2). No patient with a torn LT had a center edge angle less than 20°. On physical examination, there were no differences in FABER distance test, or hip dial test between groups. Thirty-two of the 33 hips with torn LT had a positive impingement test and 189 of 233 hips with normal LT had a positive impingement test. Hips with torn LT were 7.5 times more likely to have a positive impingement test than hips with normal LT (95% CI, 1.05-150.5). Although not significant, hips with LT had decreased flexion and increased internal rotation.

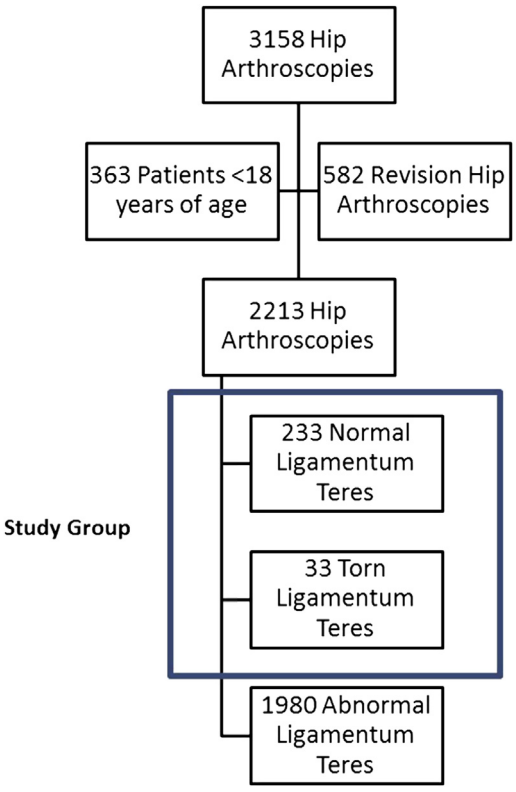

Fig 4. Patient selection for study group.

Table 1. Demographics of Patients With Hips With Torn LT and Those With Normal LT

Characteristic	Normal LT (n = 233)	Torn LT (n = 33)	*P* Value
Age, yr	35 (12)	39 (11)	.105 (1 − β = .6)
Gender ratio, male/female, n	141:92	11:22	.004*
Body mass index, kg/m^2	24.7 (3.8)	22.5 (3.6)	.003*
Months from onset of symptoms to surgery	35.8 (51.5)	33.3 (37.2)	.797 (1 − β < .5)

NOTE. Values are mean (standard deviation) unless otherwise noted. 1 − β = post hoc power.
LT, ligamentum teres.
*Statistically significant difference.

At arthroscopy, hips with torn LT were 3.1 times more likely to have a chondral defect on the femoral head than hips with normal LT (95% CI, 1.2-8.7; Table 3). Of the 27 hips with femoral head chondral defects, 11 had the defects in the perifoveal region, 10 on the weight-bearing surface, and 6 in the peripheral compartment. No differences were seen for acetabular cartilage defects. Hips with torn LTs were 3.6 times more likely to have capsular laxity diagnosed at hip arthroscopy than hips with normal LT (95% CI, 1.4-9.4). Of the 9 hips with capsular laxity, 3 had anterior capsular laxity and 6 had global capsular laxity. The presence and size of labral tears were similar between groups.

Discussion

This study showed that among patients undergoing arthroscopic treatment for FAI, the presence of a

Table 2. Preoperative Examination Findings

	Normal LT	Torn LT	*P* Value
Lateral joint space, mm	3.95 (1.1)	3.65 (1.4)	.164
Anterior joint space, mm	3.6 (0.8)	3.7 (1.2)	.592
Tönnis angle, °	6.4 (7)	8.9 (6.3)	.009*
Center edge angle, °	34.6 (7.3)	33.2 (12)	.067
<25°, n (%)	16 (7)	9 (27)	.001*
Sharp angle, °	38.8 (8.2)	38 (7.2)	.384
Positive anterior impingement, %	81	97	.023*
Flexion, °	115 (14)	109 (15)	.155
Abduction, °	48 (14)	47 (11)	.571
Adduction, °	23 (11)	26 (14)	.529
Internal rotation, °	25 (14)	32 (19)	.235
External rotation, °	43 (13)	43 (17)	.809

NOTE. Values are mean (standard deviation) unless otherwise noted.
LT, ligamentum teres.
*Statistically significant difference.

Table 3. Pathologies Identified at Hip Arthroscopy

	Normal LT (n = 233)	Torn LT (n = 33)	*P* Value
Labral tear			
Tear, %	94	100	.232
Tear size, mm, M (SD)	29 (14)	31 (17)	.591
Acetabular cartilage defect, n (%)			
Grade I to IV	173 (74)	26 (79)	.672
Femoral head cartilage defect, n (%)			
Grade I to IV	138 (59)	27 (82)	.013
Capsular laxity, n (%)	22 (9)	9 (27)	.007

LT, ligamentum teres; M, mean; SD, standard deviation.

complete LT tear was rare; however, the prevalence of LT pathology with FAI was higher than previously reported (between 4% and 17.5%).[10,11] Complete LT tears were more likely to be seen in women and patients with lower BMI, low center edge angles, and higher Tönnis angles.

Previous studies have reported on the presence of LT pathology during hip arthroscopy. Philippon et al. determined a prevalence of 78.5% for LT tears caused by hip dislocations in professional athletes,[7] as well as the presence of LT lesions in 26 of 28 professional hockey players undergoing arthroscopic labral repair and treatment for FAI.[8] In 2 separate studies, Byrd and Jones[11,12] reported a prevalence of 15 and 25% in a general patient population and an athlete specific population, respectively. Of note, this study did not take into consideration a classification of the tears. Botser et al.[13] found a prevalence of 51% of LT pathology, which included hypertrophy, partial and full thickness tears, as well as osteochondral avulsions. A higher prevalence of complete tears was reported compared with our study (5% *v* 1.5%).

Overall we found that the patients with LT tears were older and female. In a recent systematic review, 4 case series and 5 care reports were selected for review.[5] The patients were predominately female, with an age range of 14 to 78. In our study, we also found that the BMI was lower; however, this may be a confounding factor associated with female sex. Increased laxity has also been associated in female sex.[14] Patients with complete LT tears were more likely to have intraoperative findings of capsular laxity. Several studies describe the LT as a stabilizer within the hip (mainly during end-range of hip rotation, dominantly at 90° or more of hip flexion),[15] and a torn LT may lead to micro-instability.[15-17] The importance of the soft tissue surrounding the hip in the maintenance of normal joint biomechanics has already been emphasized by Clohisy et al.[18] and Bedi et al.[19]

In concordance with Domb et al.,[9] patients with complete LT tears also exhibited a significant decrease in center edge angle measurements. However, there was no difference in the Sharp angle, which is also used to quantify the degree of hip dysplasia. The relation between the ligamentum teres and dysplasia is unclear; however, this may be an adjunct to the relation with hip stability.

Historically, the physical examination findings in patients with LT tears have varied in literature. Analyzing patients who underwent hip arthroscopy for various intra-articular diagnoses, Botser et al.[13] published a case series regarding LT lesions. They reported that patients with a torn LT had a significant increase in range of motion for flexion and internal rotation.[13] Multiple studies have also reported the presence of pain with range of motion, especially during internal rotation and extension among patients with any type of LT lesion.[4,8,11] The loss of flexion is commonly due to pain, and the increased internal rotation may be another factor associated with micro-instability in the presence of a completely torn LT. In the current study, there were no significant differences in range of motion, but there were more positive impingement tests in patients with torn LT. This could be due to loss of flexion and/or pain with flexion.

Limitations

There are several limitations to this study. The hip examination maneuvers performed were specific for FAI and related pathologies; however, when this study was started, there were no maneuvers to test the LT in isolation. It is possible that concomitant pathology associated with FAI could influence the reported differences found on physical and radiographic examinations. Also, none of the physical examinations were performed while the patient was under anesthesia. Each examination was performed while the patient was awake, and therefore there is a possibility that involuntary muscle contraction caused by pain could affect the reported range of motion. Also, only 1 surgeon made all determinations of LT pathology intraoperatively. As stated previously, we believe that despite advancements in knowledge regarding the function and importance of the LT, there has not been a corresponding improvement in diagnostic techniques to detect this pathology. The present study was able to delineate some of the important characteristics pertaining to the physical examination and radiographic findings of FAI patients with LT tears and its prevalence. Despite the inability to identify a finding on either physical or radiographic examination unique to an injured LT, the information presented in the current study will help to develop an accurate diagnostic algorithm.

Conclusions

Among patients with FAI and labral pathology, complete tears of the LT were rare and were more likely to be seen in women and those with lower BMI and

low center edge angles at arthroscopy. In addition, LT tears were associated with hip laxity and chondral defects of the femoral head.

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