

Cross-Sectional Analysis of the Iliopsoas Tendon and Its Relationship to the Acetabular Labrum

An Anatomic Study

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Background: Hip pain in patients with normal bony anatomy and anterior labral injury may be related to compression of the iliopsoas tendon across the anterior capsulolabral complex. No attempts to characterize the 3-dimensional anatomy of the iliopsoas tendon and its relationship to the acetabular labrum have been reported to date.

Hypothesis: The iliopsoas tendon directly overlies the capsulolabral complex. Contribution of the muscle belly and tendon to the overall circumference at the level of the labrum is approximately the same.

Study Design: Descriptive laboratory study.

Materials and Methods: Eight hip joints were dissected and cross-sectional measurements of the iliopsoas muscle-tendon complex were performed using digital calipers and image analysis software.

Results: The iliopsoas tendon in all specimens was located directly anterior to the anterosuperior capsulolabral complex at the 2 to 3 o'clock position. The overall length of the iliopsoas tendon from the lesser trochanter to the acetabular labrum was 75.4 ± 0.9 mm. The circumference of the iliopsoas tendon at the lesser trochanter was 25.5 ± 2.6 mm, the iliopsoas tendon at the level of the labrum was 28.4 ± 2.8 mm, and the iliopsoas tendon-muscle belly complex at the level of the labrum was 63.8 ± 7.4 mm. At the level of the labrum, the iliopsoas is composed of 44.5% tendon and 55.5% muscle belly.

Conclusion: The close anatomic relationship of the iliopsoas tendon to the anterior capsulolabral complex suggests that iliopsoas pathologic changes at this level may lead to labral injury. Additionally, these data suggest that at the level of the labrum, 45% of the tendon-muscle belly complex should be released to release the entire tendinous portion.

Clinical Relevance: Knowledge of the cross-sectional anatomy of the iliopsoas tendon and its relationship to the acetabular labrum will better assist surgeons in treating lesions associated with iliopsoas injury.

Keywords: iliopsoas; acetabulum; hip arthroscopy; cross-sectional anatomy

The iliopsoas tendon has been implicated in a variety of pathologic lesions. In the "internal snapping hip syndrome," during hip motion from flexion to extension, the iliopsoas tendon catches on the iliopectineal eminence or snaps across the femoral head.² This syndrome can be the

cause of debilitating mechanical groin pain. The iliopsoas tendon has also been documented as a source of patient pain and discomfort after total hip arthroplasty, termed "iliopsoas impingement" because the tendon impinges on an overhanging acetabular component.¹⁰

Some authors have also suggested that this same iliopsoas impingement can be a cause of labral tears in the native hip. In patients with normal bony anatomy, a tight iliopsoas tendon could cause compression over the anterior capsulolabral complex, leading to labral lesions. Heyworth et al,⁷ in a review of findings at revision hip arthroscopy, found labral tears at the 2 to 3 o'clock position, directly adjacent to the iliopsoas tendon. These tears were more

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anterior than traumatic labral tears or those tears associated with femoroacetabular impingement, which are classically found at the 11:30 to 1 o'clock position.

Defining the anatomic relationship between the iliopsoas tendon and the labrum would add insight to our understanding of the mechanics of hip function and labral lesions. To date, and to the best of our knowledge, no attempts to characterize the 3-dimensional anatomy of the iliopsoas tendon have been reported. Therefore, the purpose of this study is to identify the cross-sectional anatomy of the iliopsoas tendon at the level of the labrum and at the level of the lesser trochanter. The length of the iliopsoas tendon at the labrum to its insertion to the lesser trochanter will also be quantified. Finally, the percentage of iliopsoas tendon to iliopsoas muscle belly–tendon complex at the level of the labrum will also be measured.

Knowledge of the anatomy of the iliopsoas tendon and its relationship to the labrum will help orthopaedic surgeons to better understand the intricate framework of anatomy in this area, and aid in both open and arthroscopic treatment of labral and iliopsoas pathologic lesions.

MATERIALS AND METHODS

A controlled laboratory design was performed using 4 fresh-frozen cadaveric pelvic specimens (average age, 72 years) for a total of 8 hip dissections. The specimens were procured at the level of C7 proximally and at midhigh distally to preserve the proximal and distal attachment sites of the iliopsoas tendon. All specimens were examined with direct visualization and fluoroscopy before testing. There was no evidence of degenerative joint disease, prior trauma, neoplastic infiltration, or prior surgery.

A 10-cm longitudinal incision was made just distal to the anterior superior iliac spine. A dissection was performed via a Smith-Petersen approach through the interval between the tensor fascia lata and sartorius down to the rectus femoris (Figure 1). The 2 heads of the rectus femoris were transected and the muscle belly was reflected proximally. The femoral nerve, artery, and vein were then identified medial to the reflected muscle on top of the iliacus muscle belly.

Soft tissue dissection continued distally to visualize the entire iliopsoas tendon as it inserts posteromedially into the lesser trochanter. The iliopsoas muscle and tendon were then identified medially at the level of the hip capsule (Figure 2). Further dissection continued down to the hip capsule at the level of the anterolateral labrum. A T-shaped capsulotomy enabled visualization of the underlying acetabular labrum and its relationship adjacent to the overlying iliopsoas tendon (Figure 3).

Digital calipers (Microscribe Solution Technologies, Oella, Maryland) and image analysis software (Rhinoceros v. 4.0, Robert McNeal and Associates, Seattle, Washington) were used to make several cross-sectional measurements. Measurements included the diameter of the insertion of the iliopsoas tendon at the lesser trochanter, the iliopsoas tendon at the level of the labrum, and the iliopsoas muscle belly–tendon complex at the level of the labrum. Tendon

measurements were made at the level the iliopsoas tendon crosses the acetabular labrum. Additional measurements included the longitudinal distance of the iliopsoas tendon at the level of the lesser trochanter to the tendon at the level of the labrum. Finally, the percent of iliopsoas tendon to iliopsoas muscle belly–tendon complex was measured at the level of the labrum.

RESULTS

The overall length of the iliopsoas tendon from the lesser trochanter to the acetabular labrum was 75.4 ± 0.8 mm (Table 1). The circumference of the iliopsoas tendon at the lesser trochanter was 25.5 ± 2.5 mm, the iliopsoas tendon at the level of the labrum was 28.3 ± 2.8 mm, and the iliopsoas tendon–muscle belly complex at the level of the labrum was 63.7 ± 7.3 mm. At the level of the labrum, the iliopsoas is composed of 44.5% tendon and 55.5% muscle belly. The iliopsoas tendon in all specimens was located directly anterior to the anterosuperior capsulolabral complex (2 to 3 o'clock position on a right hip) (Figure 4).

DISCUSSION

It has been noted that labral tears are usually caused by trauma, femoroacetabular impingement, capsular laxity/hip mobility, dysplasia, or degeneration and are usually located at the 11:30 to 1 o'clock position (Figure 4).^{3,8} These tears are clinically significant and are commonly treated because the acetabular labrum maintains joint congruity and acts as a sealant to the hip joint, maintaining negative intra-articular pressure to keep the hip joint stabilized.⁶ We have noted at primary and revision hip arthroscopy that labral tears also occur at the 2 to 3 o'clock position, directly adjacent to the iliopsoas tendon. We therefore decided to study the anatomy of this area.

The iliopsoas muscle originates at the transverse processes of T12 to L5. The iliacus muscle originates at the superior 2/3 of the iliac fossa. The iliopsoas is formed from the muscle belly of the psoas and iliacus, is composed of muscle belly and tendon at the level of the labrum, and attaches to the lesser trochanter. Its principal function is as a hip flexor and it also has a role in maintaining erect posture.

We found that the overall length of the iliopsoas tendon from the lesser trochanter to the acetabular labrum was 75.4 ± 0.8 mm. The circumference of the iliopsoas tendon at the lesser trochanter was 25.5 ± 2.5 mm, the iliopsoas tendon at the level of the labrum was 28.3 ± 2.8 mm, and the iliopsoas tendon–muscle belly complex at the level of the labrum was 63.7 ± 7.3 mm. At the level of the labrum, the iliopsoas is composed of 44.5% tendon and 55.5% muscle belly (Figure 5). The iliopsoas tendon was located directly anterior to the anterosuperior capsulolabral complex at the 2 to 3 o'clock position. This anatomic close proximity and the location of labral tears suggests that the iliopsoas may also be implicated as a cause of labral tears.

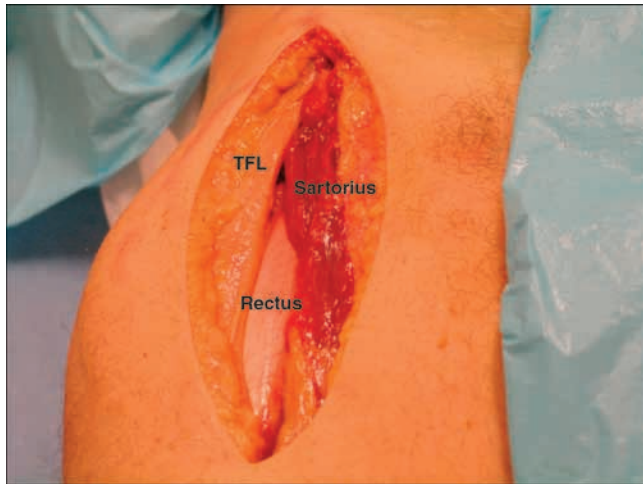


Figure 1. The Smith-Petersen approach was used through the interval between the tensor fascia lata (TFL) and sartorius down to the rectus femoris.

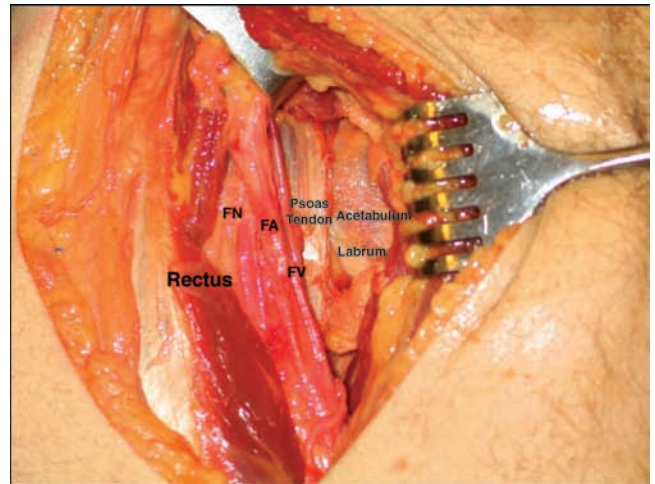


Figure 3. Visualization of the acetabular labrum after a T-shaped capsulotomy. The femoral artery (FA), femoral vein (FV), and femoral nerve (FN) were also identified and retracted laterally during the dissection for visualization purposes.

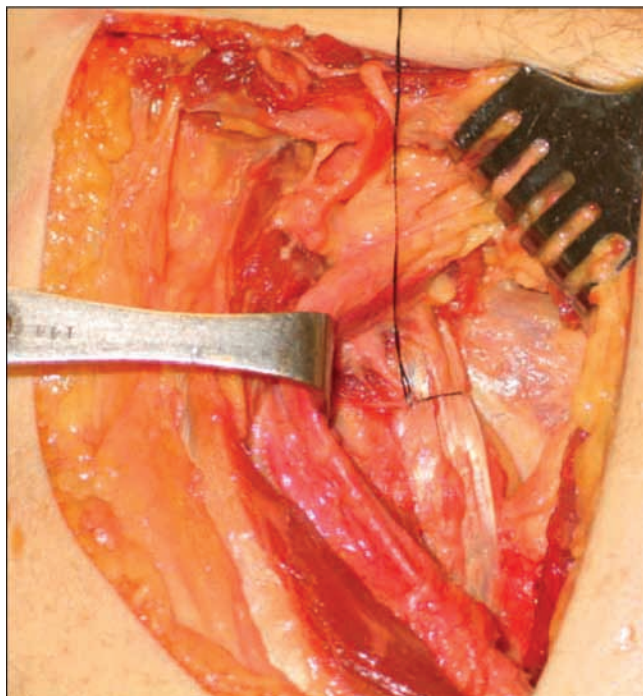


Figure 2. Identification of the iliopsoas muscle and tendon medially at the level of the hip capsule. Soft tissue dissection continued distally to visualize the entire iliopsoas tendon at its insertion posteromedially into the lesser trochanter.

The iliopsoas tendon has recently been implicated as a cause of labral lesions. Flanum et al⁵ arthroscopically treated 6 patients with a painful snapping hip at the level of the lesser trochanter. Five patients were noted intraoperatively to have labral tears that were treated with labral debridement. Ilizaliturri et al¹⁰ noted that 4 of

TABLE 1
Cross-Sectional Anatomy of the Iliopsoas Muscle-Tendon Complex at Different Levels and the Length of the Iliopsoas Tendon From Lesser Trochanter (LT) to Labrum^a

	Muscle at Labrum (mm)	Tendon at Labrum (mm)	Tendon at LT (mm)	LT to Labrum (mm)	
				Average of 4 Tries	SD
Cadaver 1, right	75	25	29	93.0	0.3
Cadaver 1, left	67	32	27	96.6	0.7
Cadaver 2, right	68	29	27	66.2	1.2
Cadaver 2, left	68	31	28	68.9	1.4
Cadaver 3, right	64	26	23	74.6	1.4
Cadaver 3, left	60	31	22	78.0	0.1
Cadaver 4, right	53	25	24	64.1	0.9
Cadaver 4, left	55	28	24	66.3	0.5
Average	63.7	28.3	25.5	75.4	0.8
SD	7.3	2.8	2.5		

^aRepeatability is represented by standard deviations (SD). LT, lesser trochanter.

6 patients undergoing arthroscopic iliopsoas tendon release had labral lesions. In addition, there is growing recognition that the psoas tendon, as it crosses the anterior aspect of the hip joint, can play a role in the pathophysiology of acetabular labral impingement, even in patients without a formal diagnosis of “snapping hip.” In this series of revision hip arthroscopy procedures by Heyworth et al,⁷ 7 of 24 patients were seen to have a tight psoas tendon overlying and impinging on a torn or inflamed anterior labrum. In each case, a partial psoas release of the tendinous portion of the musculotendinous unit at that

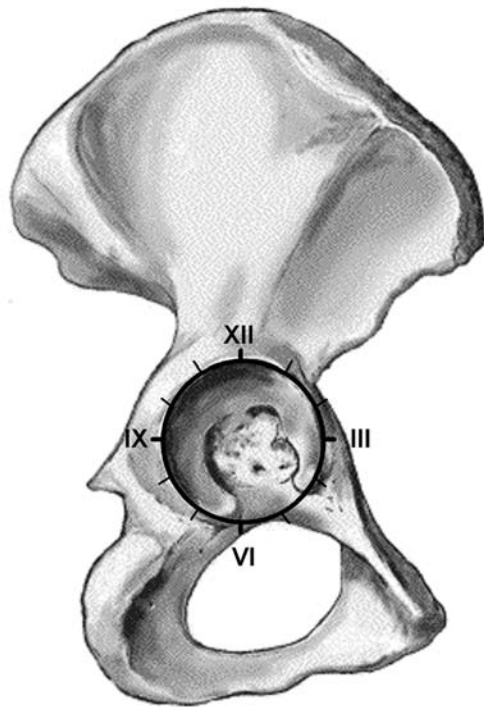


Figure 4. The clock-face anatomy of the acetabulum.

level was performed, and the labrum was observed arthroscopically to be free of impingement from the tendon when the hip was moved through its range of motion.

Labral pathologic lesions can lead to significant disability secondary to groin pain, mechanical symptoms, and decreased range of motions.¹⁴ Some authors have suggested that labral lesions are implicated in the development of degenerative joint disease. McCarthy et al¹³ evaluated 436 arthroscopies and found 241 labral tears. Of those, 225 (86%) were in the anterior quadrant of the acetabulum. They subsequently dissected 54 adult cadavers, identifying 113 labral lesions, with the majority located in the anterosuperior (27%) and anterior (20%) aspects of the acetabulum. Finally, Fitzgerald⁴ reported that 92% of all labral tears were located anteriorly. Therefore, it seems likely that the iliopsoas tendon could play a role in the location of this labral lesion. This statement can be supported by the results of the present study. We noted that the iliopsoas muscle-tendon unit directly overlies the capsulolabral complex at the 2 to 3 o'clock position.

Pathologic changes associated with the iliopsoas tendon occur as the tendon catches on the iliopectineal eminence or snaps on the femoral head as the hip is brought from flexion, abduction, and external rotation to extension, adduction, and internal rotation.^{9,11} This is manifested clinically as a painful snapping hip. Initial treatment consists of a course of stretching, physical therapy modalities, oral medications, and bursal injections. When surgery is indicated, open and arthroscopic techniques have been described, which include fractional lengthening of the iliopsoas tendon muscle unit, release of the tendon at the level of the hip joint, or

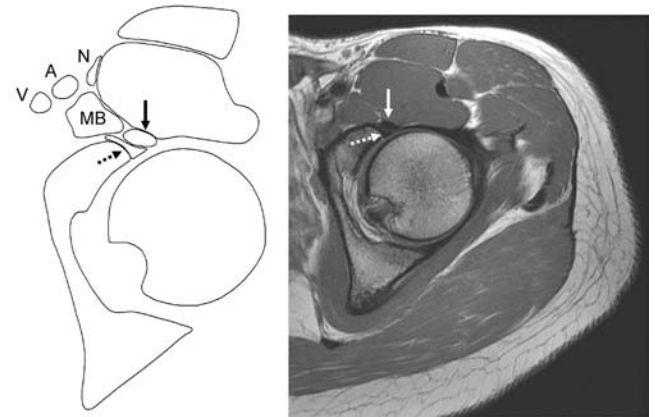


Figure 5. Magnetic resonance image of the hip showing the cross-sectional anatomy in the transverse plane. The solid and dashed arrows mark the iliopsoas tendon and acetabular labrum, respectively. MB, muscle belly of iliopsoas; N, femoral nerve; A, femoral artery; V, femoral vein.

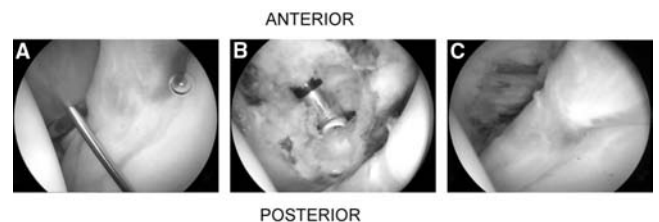


Figure 6. Arthroscopic visualization of the iliopsoas and acetabular labrum via a standard anterolateral portal. A, diagnostic arthroscopy. The arthroscopic probe is passed from anterior to posterior under the tendinous portion of the iliopsoas and just anterior to the labrum. B, surgical release of the tendinous portion of the iliopsoas. C, the muscle belly superficial to the tendon is left intact.

release of the tendon at its insertion to the lesser trochanter.^{1,2,5,6,8,10,11,14} Complications include persistent pain, recurrent snapping, and flexor weakness; wound problems are relatively common.

Arthroscopic treatment of the iliopsoas tendon has been described as a surgical release at the lesser trochanter or at the level of the labrum through a small capsulotomy.^{1,5,7,12} Although it has not been validated by Cybex testing, it is possible that releasing the tendon at the level of the lesser trochanter could ultimately be equivalent to releasing the entire muscle belly-tendon complex. The results of this study suggest that a release at the level of the labrum would still leave approximately 55% of the muscle belly complex intact and may have implications in maintaining overall hip flexion strength.

On the basis of the data in this study, we suggest that to release the tendinous portion of the iliopsoas unit at the lesser trochanter and maintain the muscle belly of the iliacus, approximately 45% of the iliopsoas unit should be released (Figure 6). There also may be an inherent risk

of recurrence of iliopsoas impingement in releasing the iliopsoas tendon at the level of the lesser trochanter, as the location of the remaining iliopsoas tendon may lead to continued compression at the level of the labrum. It is unlikely that distal release of the tendon will lead to retraction greater than the overall length of the tendon, which in the present study was measured as 75.4 ± 0.8 mm.

To further evaluate our claim that the iliopsoas tendon is a cause of labral lesions, future studies should measure the contact pressures before and after tenotomy to clarify whether contact pressures are reduced after iliopsoas tendon release. Biomechanical studies should also be carried out to determine the tensile properties of the iliopsoas tendon and kinematic behavior of the hip joint before and after surgical release of the tendon.

CONCLUSION

This study depicts the anatomic relationship of the iliopsoas muscle-tendon unit to its surrounding structures. The cross-sectional area of the tendon at the level of the hip labrum and at the level of the lesser trochanter was also evaluated. We noted that the iliopsoas muscle-tendon unit was directly overlying the capsulolabral complex at the 2 to 3 o'clock position on the labrum, which suggests that it could play a role in anterior or anterosuperior labral lesions. This can provide guidance for intraoperative decision making based on the location of the labral pathologic changes seen in the joint. At the level of the labrum, the iliopsoas is composed of 55.5% muscle belly and 44.5% tendon. We recommend iliopsoas tendon release at the level of the labrum arthroscopically via a capsulotomy as opposed to at the lesser trochanter. Our study shows that the length of the tendon between these structures was measured as 75.4 ± 0.8 mm and may not retract above the level of the labrum. The cross-sectional area of iliopsoas tendon at the level of the labrum is approximately 28.3 mm. Furthermore, these data suggest that at the level of the labrum, about 45% of the tendon-muscle belly complex should be incised to release the entire tendinous portion.

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