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ORIGINAL ARTICLE

Iliopsoas Impingement: A Newly Identified Cause of Labral Pathology in the Hip

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Abstract Labral tears typically occur anterosuperiorly in association with femoroacetabular impingement or dysplasia. Less commonly, labral pathology may occur in an atypical direct anterior location adjacent to the iliopsoas tendon in the absence of bony abnormalities. We hypothesize that this pattern of injury is related to compression or traction on the anterior capsulo-labral complex by the iliopsoas tendon where it crosses the acetabular rim. In a retrospective review of prospectively collected data, we identified 25 patients that underwent isolated, primary, unilateral iliopsoas release and presented for at least 1 year follow-up (mean 21 months). Pre-operative demographics, clinical presentation, intra-operative findings, and outcome questionnaires were analyzed. The injury was treated with a tenotomy of the iliopsoas tendon at the level of the joint line and either labral debridement or repair. Mean post-operative outcome scores were 87.17, 92.46, and 78.8 for the modified Harris Hip Score, activities of daily living Hip Outcome Score, and sports-related score, respectively. The atypical labral injury identified in this study appears to represent a distinct pathological entity, psoas impingement, with an etiology which has not been previously described.

Keywords psoas impingement · hip arthroscopy · labral tears

Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has approved the reporting of this case, that all investigations were conducted in conformity with ethical principles of research.

Level of Evidence: Level IV: Case Series

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Introduction

Recent developments in hip arthroscopy have led to increased recognition of labral tears in the hip [2, 4, 7, 12, 14, 19, 21, 22, 27, 29–31]. Multiple etiologies have been identified, including femoroacetabular impingement (FAI), trauma, dysplasia, capsular laxity, and degenerative joint disease. The vast majority of labral tears are associated with bony abnormalities, including bony lesions seen with FAI [40].

The most common location of labral tears is in the anterosuperior region, which can be accurately described as the 1 to 2 o'clock position [4, 29]. This location corresponds to the most frequent area of impingement in FAI, which generally occurs in hip flexion, adduction, and internal rotation. However, we have observed a distinct pattern of labral pathology which occurs in a direct anterior location in the labrum or 3 o'clock position, which could not be attributed to any of the known etiologies of labral injuries. This was a distinct 3 o'clock lesion, exactly at the iliopsoas notch, without any extension anterosuperiorly. In other words, it was too focal to be related to femoroacetabular impingement or dysplasia. These injuries have included some labra with frank tears and mucoid degeneration, while other labra have an inflamed appearance without a tear. We have recognized that these labral injuries at the 3 o'clock position consistently occur directly beneath the iliopsoas tendon, which lies in an extra-articular position immediately adjacent to the capsule at the 3 o'clock position.

The consistent relationship of the direct anterior labral pathology with the iliopsoas tendon led us to hypothesize that the tendon is involved in the pathogenesis of the labral injury. For purposes of descriptive nomenclature, we refer to this condition as iliopsoas impingement (IPI). We further theorized that in addition to labral debridement, treatment of the underlying pathology by arthroscopic tenotomy of the iliopsoas may be effective.

The purpose of this study is to describe the clinical presentation, intra-operative findings, and clinical outcomes of patients with iliopsoas impingement. What follows is a descriptive report of our novel finding of a distinct pathologic entity of the labrum and a discussion of its biomechanical basis.

Methods

Since August 2006, we prospectively studied 640 hip arthroscopies all performed by the senior author (BK). Of these, we identified 36 hips in which arthroscopic examination revealed a labral injury at the 3 o'clock position which could not be attributed to any of the known causes of labral pathology. All patients had preoperative plain radiographs including an AP pelvis and an elongated-neck lateral view (hip in 90° of flexion and 20° abduction) of the affected hip. In addition, all patients had a magnetic resonance imaging scan performed of the affected hip. Based on these studies, there was no evidence of dysplasia (center edge of Wiberg >25°), acetabular retroversion (negative crossover sign), or cam lesions (alpha angle <50°). They had no injuries to the articular cartilage, no history of trauma or instability, and no injury in any part of the labrum other than the direct anterior site.

Out of these 36 patients, 25 patients underwent isolated, primary, unilateral iliopsoas release and presented for at least 1-year follow-up. Eleven patients were lost to follow-up prior to the 1-year mark. Patients were asked to fill out outcome questionnaires at each follow-up visit. Questionnaires consisted of four separate outcomes measures: a modified Harris Hip score (HHS), a Hip Outcome score (HOS), which included a score for activities of daily living (ADL), as well as a sport-related score (Sport HOS), and finally a subjective assessment of patient outcome wherein the patient was asked to rate overall physical ability since the initiation of treatment. The answer choices were normal, nearly normal, abnormal, and severely abnormal. The HHS, HOS, and Sport HOS all had scales of 0–100, with 100 being the maximum score.

Surgical Technique

All arthroscopies were performed in the supine position. The arthroscope was initially inserted through an anterolateral portal in all cases. Anterior, posterolateral, and distal lateral accessory (DLAP) portals were used as necessary. Complete inspection of the central compartment was performed, with care to evaluate for the presence of injury to any part of the labrum, articular cartilage damage, or pincer lesion. In most cases, the DLAP portal was used as the primary working portal.

In cases with a tear of the labrum, the torn portion was debrided using the shaver (23 patients) or reattached using suture anchors (two patients). An anterior capsulotomy approximately 1 cm in length was made directly anterior to the labral injury using the beaver blade or radiofrequency ablation device. Through this capsular window, the tendinous portion of the iliopsoas could be visualized (Fig. 1). The shaver was used to peel any adherent portions of the iliopsoas off of the capsule. The tendinous portion of the iliopsoas was then incised through either the DLAP or an anterior portal from lateral to medial using the beaver blade. Careful attention was paid to avoid damage to any of the nearby neurovascular structures.

After the labral injury was addressed and the psoas tendon was released, traction was removed from the lower extremity. The hip was flexed to 45°, and the arthroscope was moved into the peripheral compartment. The surgery was completed with a thorough inspection of the peripheral compartment with care to note the presence of a cam lesion or capsular-sided labral abnormality.

Results

All patients included in this report presented with complaints of anterior hip pain. There were 2 male and 23 female patients. The average age was 25.1 (range 15 to 37). Eight of the patients had L hip pathology and 17 had right hip pathology. Twenty of the patients were involved in regular sports including: track and field, cross country, swimming, basketball, gymnastics, dance, martial arts, softball, soccer, tennis, and hockey. On physical examination, all patients had pain with passive flexion-adduction-internal rotation (impingement test), and all had focal tenderness over the iliopsoas at the level of the anterior joint line. However, focal tenderness is a nonspecific finding and should not be independently used as a diagnostic criterion for iliopsoas problems. Twenty patients received intra-articular injection preoperatively. Of these

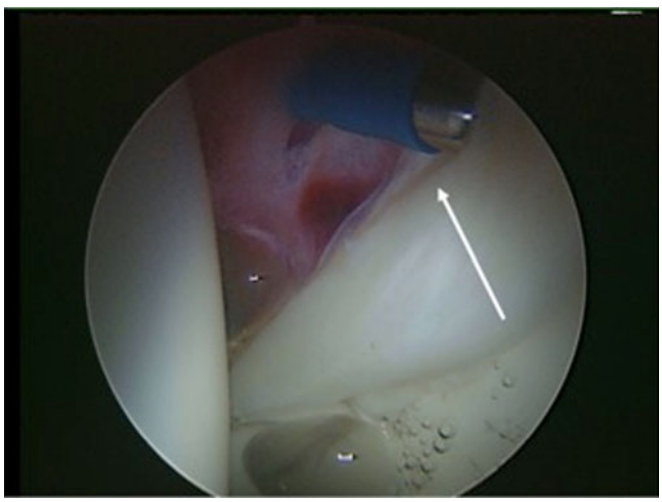

Fig. 1. Arthroscopic image demonstrating the iliopsoas impingement sign with labral inflammation (*white arrow*)

patients, ten reported at least transient relief lasting from weeks to months and seven reported minimal or no relief. Four patients received a psoas injection preoperatively. One patient reported good but transient relief. None of these patients had radiographic evidence of bony abnormalities associated with labral tears such as decreased head–neck offset, dysplasia, acetabular retroversion, or profunda acetabuli. All patients demonstrated labral abnormality on MRI.

Upon arthroscopic inspection, all hips in this series contained an isolated injury to the labrum at the 3 o'clock position. In some cases, this injury consisted of an inflamed appearance of the iliopsoas tendon (Fig. 2) and labrum without frank tear (Fig. 3), which we refer to as the IPI sign. In other cases, there was a tear or mucoid degeneration of the labrum. Torn labra were either debrided or reattached to the acetabular rim depending on the pattern of the tear. In all cases, anterior capsulotomy revealed that the labral injury was directly adjacent to the tendinous portion of the iliopsoas muscle. In many cases, the iliopsoas was adherent or scarred to the anterior capsule. Due to the intimate relationship of the labral injury with the crossing of the iliopsoas tendon (Fig. 4), it was concluded that the injury was associated with tightness or adherence of the tendon which could be treated by tenotomy. Transection of the tendinous portion of the muscle allowed the edges of the tendon to gap apart, implying that tension had been released (Fig. 5). By releasing the psoas tendon, we believe that we are treating the underlying pathology by removing the tension placed on the labrum by the adjacent psoas tendon.

Of the 25 patients who presented for at least 1-year follow-up, 10 patients described their physical ability as much improved, 12 as improved, and 1 as no change. Two patients left the question blank. No patient reported their physical ability as slightly worse, worse, or much worse. Mean post-operative outcome scores were 87.17, 92.46, and 78.8 for the HHS, ADL, HOS, and Sport HOS, respectively. Eight of the patients had also filled out preoperative outcome questionnaires. For these patients, the mean preoperative HHS, ADL HOS, and Sport HOS scores were 61.64, 73.94, and 51.63, respectively, whereas the mean post-operative scores were 86.06, 88.21, and 72.01, respectively (p=0.008, 0.02, 0.04).

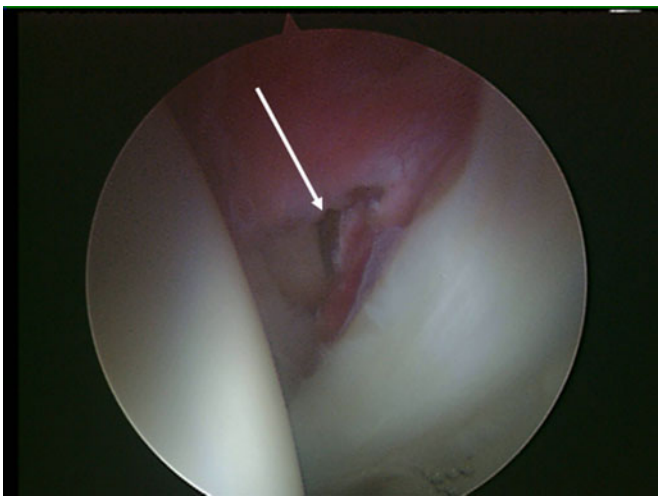

Fig. 2. Arthroscopic image after capsulotomy for visualization of the iliopsoas tendon (*white arrow* capsular window)

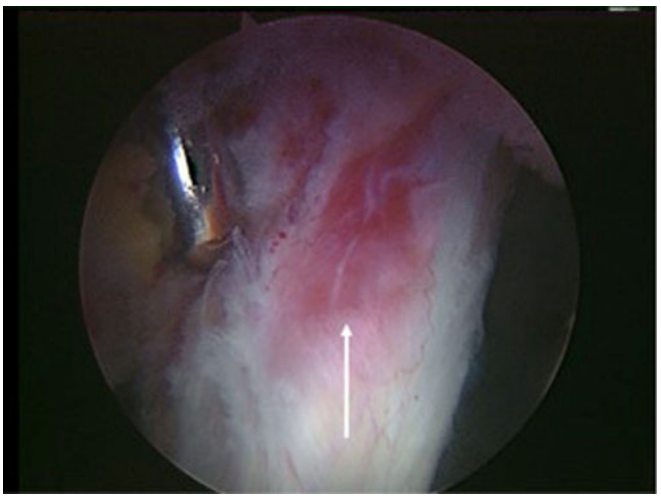

Fig. 3. Arthroscopic image demonstrating inflammation of the iliopsoas tendon (*white arrow*)

Discussion

The purpose of this study is to describe the clinical presentation, intra-operative findings, and clinical outcomes of patients with iliopsoas impingement. The authors observed a distinct pattern of hip pain associated with a labral injury at the 3 o'clock or direct anterior position. In this series, we identified 36 hips with isolated direct anterior labral pathology with no evidence of FAI, bony abnormality, trauma, or any other known cause of labral injury. Clinical presentation in all cases included anterior hip pain and pain with active flexion, while some patients also experienced snapping sensations. Physical examination consistently revealed focal tenderness at the iliopsoas, positive impingement test, and pain or apprehension with resisted straight leg raise. While some patients had incomplete relief of the pain with an intra-articular

Fig. 4. Arthroscopic image demonstrating an intimate association among the labrum (*black arrow*), capsule (*white arrow*), and iliopsoas tendon (*white arrowhead*)

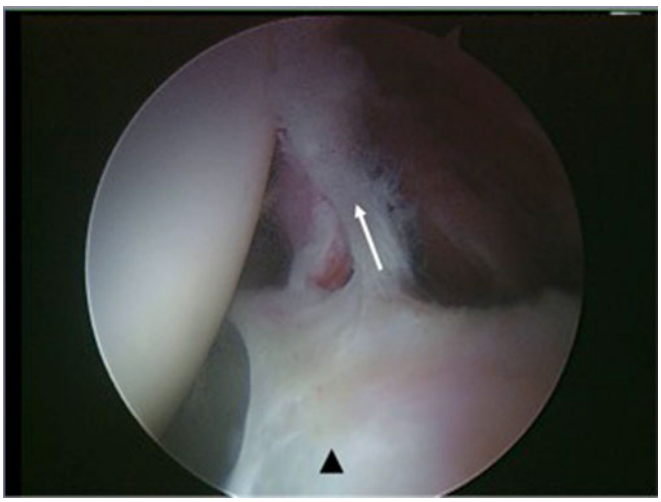

Fig. 5. Arthroscopic image after release of the iliopsoas tendon which now only demonstrates the labrum (*black arrowhead*) and capsule (*white arrow*) because the iliopsoas tendon has retracted

injection, many of these patients had more complete relief after a psoas injection. Arthroscopic findings were most notable for the intimate relationship between the labral pathology and the iliopsoas tendon, which in all cases lay directly anterior to the labral abnormality. Patients had subjective and objective improvement at an average follow-up of 21 months.

There are several limitations of this study. First, this is a retrospective review of prospectively collected data. Eleven patients out of 36 were lost to follow-up. Exhaustive attempts were made to contact these patients without success. If these patients were dissatisfied, this could potentially change our results, but this is an inherent limitation of the retrospective nature of this study.

Recent advances in the understanding of pre-arthritic hip conditions and the development of enhanced arthroscopic techniques have led to a growing recognition of FAI as a common cause of hip pain. FAI is thought to be a common cause of labral tears and may also lead to cartilage damage and eventually osteoarthritis [2, 20, 36]. Labral tears associated with FAI are most often located in the antero-superior region, a site which corresponds to the pain generally induced by the impingement test with flexion, adduction, and internal rotation. Early clinical results suggest that labral tears caused by FAI may be effectively treated by labral debridement or repair accompanied by correction of bony deformities including cam and pincer lesions [1–3, 5, 11].Our observations suggest that the 3 o'clock labral injury represents a distinct entity not associated with any of the known causes of labral tears. The consistent spatial relationship with the iliopsoas tendon implies that the tendon may play a contributory role in this condition. Once injured, it is likely that the labrum would generate pain when compressed with flexion, adduction, and internal rotation, explaining the positive impingement test. We propose three theoretical explanations for the distinct 3 o'clock labral injury observed in this study: (1) a tight or inflamed iliopsoas causes impingement of the anterior labrum in hip extension; (2) the iliopsoas tendon becomes scarred or adherent to the anterior capsulo-labral complex, leading to a repetitive traction injury; or (3) a hyper-active iliocapsularis muscle causes labral injury by traction phenomenon.

The first explanation, impingement on the anterior labrum, is based upon the path and biomechanics of the iliopsoas. The tendon of the iliopsoas makes an obtuse angle around the iliopectineal eminence and femoral head which increases in hip extension. Maximal pressure beneath the psoas tendon occurs over the femoral head, which overshadows the iliopectineal eminence as the primary pulley of the psoas [41]. This raises the possibility that the pressure and friction exerted on the femoral head and anterior labrum during hip motion may lead to the 3 o'clock labral injury. A tight or spastic iliopsoas would further elevate contact pressures beneath the tendon, creating a predilection toward labral impingement.

In the second explanation, scarring or adherence of the iliopsoas to the anterior capsulo-labral complex would lead to a repetitive traction injury. The normal iliopsoas loses contact with the femoral head at 14° of flexion and the iliopectineal eminence at 54°, assuming a direct path to the lesser trochanter without the obtuse angle seen in extension or neutral position [41]. We propose that chronic inflammation of the iliopsoas tendon and bursa, as in painful coxa saltans, may lead to scarring of the tendon to the anterior capsule. This adherence would prevent lift-off from the capsule and lead to a reverse obtuse angle of the tendon in hip flexion. The adherent tendon would pull on the anterior capsulo-labral complex with contraction of the iliopsoas muscle. This repetitive traction would cause injury to the labrum directly beneath the crossing of the iliopsoas tendon.

The final explanation involves the iliocapsularis, which originates on the anterior joint capsule and iliopectineal eminence and inserts just distal to the lesser trochanter. This little known muscle was first observed by Ward et al. in dysplastic patients, and was consistently identified in cadaveric dissections [39]. The authors theorized that the muscle acts as an anterior stabilizer by tightening the capsule, implying that it might be hypertrophied in dysplastic or unstable hips. Hypertrophy or hyperactivity of the iliocapsularis may represent an alternative cause of repetitive traction injury on the anterior capsulo-labral complex. As the iliocapsularis and iliopsoas are immediately adjacent, it is possible that the tendon overlying at least some of the labral injuries seen in this study was in fact the iliocapsularis, not the iliopsoas.

Review of the literature on the biomechanics of the iliopsoas reveals considerable controversy. Although there is consensus regarding its action as a hip flexor, its action as a hip rotator and truncal stabilizer are subjects of debate. In a cadaveric study in 1977, Hooper established that the iliopsoas does not have a significant rotational moment across the hip joint. Other early studies suggested a significant rotatory role of the iliopsoas [16]. Rajendran performed a cadaveric study

to determine the rotatory influence of the iliopsoas at the hip joint and concluded that the spiral course of the tendon insertion around the medial femur makes the iliopsoas an external rotator [26]. However, more recent cadaveric studies have supported Hooper's original conclusion that the iliopsoas acts as a hip flexor but does not have a significant rotational effect [33]. This conclusion is further reinforced in a study by Delp et al. which used a computer model to measure the variation in rotational moment arms with hip flexion [9]. Their results demonstrated that the iliopsoas has a very small internal rotation moment at 0° and switched to an equally small external rotation moment at 90° of hip flexion. With increasing hip flexion, there was a trend toward internal rotation in 15 of the 18 muscle compartments examined. The authors concluded that although the iliopsoas does not have a significant direct influence on rotation, a short or spastic iliopsoas may indirectly contribute to internal rotation by causing hip flexion and shifting the balance of the hip rotators toward internal rotation.

Yoshio et al. studied the tension of the psoas major muscle and the pressure beneath it in 0–90° of flexion in a cadaveric model [41]. They found that tension on the tendon decreased in higher degrees of flexion as its moment arm became more advantageous for flexion. Importantly, it was noted that the femoral head, not the iliopectineal eminence, was the primary pulley over which the tendon makes an obtuse angle. Pressure beneath the tendon was higher at the level of the femoral head than at any other site. This pressure decreased with greater degrees of flexion. The authors identified five features associated with higher pressures in flexion: (1) a large femoral head; (2) a thin but wide tendon at the level of the femoral head; (3) a small neck-shaft angle; (4) high degree of femoral anteversion (30°, ranging from 13° to 30°); and (5) a relatively small angle at the pulley (123°). The finding of high pressure at the anterior femoral head and joint line supports the theory of IPI leading to labral injury. The five risk factors identified by Yoshio et al., as well as a tight or spastic iliopsoas, may put patients at risk for this pathology.

The significance of a tight or spastic iliopsoas is highlighted by considering the case of spasticity syndromes. Iliopsoas tenotomy was described as early as 1950 by Peterson in the treatment of spastic paraplegia [24]. More recently, muscle recession and tenotomy procedures have been well-described for contractures of the iliopsoas in a variety of spastic syndromes including cerebral palsy and myelomeningocele [13, 23–25, 28, 32, 34]. Feldkamp and Denker compared 20 cerebral palsy patients who had undergone soft-tissue surgery at the hip (adductor tenotomy, medial lengthening of the hamstrings) with a matched group of another 20 patients treated with the addition of iliopsoas release to the procedure. They found that addition of iliopsoas release improved the outcomes of adduction deformities and hip subluxation and dislocation [13]. Extrapolating from these spastic conditions, it is evident that a tight or spastic iliopsoas has a significant adverse effect on the hip joint and that release may alleviate the abnormal forces and symptoms that result.

As a parallel to the injury observed in this study, it is notable that IPI over the anterior acetabulum has been described by several authors in the setting of total hip arthroplasty (THA) [8, 38]. This condition may be analogous to our proposed mechanism of impingement on the anterior capsulo-labral complex. Overhang of the acetabular cup anteriorly has been associated with IPI, a scenario which may be similar to a prominent iliopectineal eminence or femoral head causing the iliopsoas to make a sharper angle [38]. IPI in THA that is unresponsive to corticosteroid injection has been successfully treated with tenotomy at the level of the acetabulum [35, 37]. Dora et al. found relief of pain in 18 of 22 hips (81.8%) treated with either tenotomy of the iliopsoas or revision of the acetabular component with debridement of the tendon [10]. They found that iliopsoas tenotomy provided the same functional results as revision of the acetabular component and avoided the risks of the latter procedure. These reports of success with tenotomy for IPI after THA support our hypothesis that tenotomy or fractional lengthening may be helpful in IPI of the native hip.

Release of the iliopsoas has been described by several authors for the treatment of internal coxa saltans. Open release of the psoas tendon has been used with moderate success [17, 37]. Hoskins et al. reported 89% patient satisfaction in 92 cases of internal coxa saltans treated with open fractional lengthening of the IP [17]. However, they found a 40% complication rate with the open technique. Several authors have described arthroscopic psoas release [6, 15, 18, 42]. Complete tenotomy has been performed at the insertion site on the lesser trochanter [22], or alternatively, fractional lengthening has also been described through the central [6] or peripheral [42] compartments. Although tenotomy has been shown to be effective for coxa saltans, patients in this study did not complain of audible snapping of the hip. Patients complained of anterior hip pain and the physical exam demonstrated pain with passive flexion-adduction-internal rotation (impingement test), and all patients had focal tenderness over the iliopsoas at the level of the anterior joint line. Thus, the authors recommend a diagnosis of IPI when the above physical exam findings are present in combination with the lack of an audible snapping of the hip.

In conclusion, the isolated direct anterior labral injury appears to be caused by a mechanism that has not been previously described to our knowledge. The intimate relationship between the iliopsoas tendon and the 3 o'clock labral injury suggests that the disorder is associated with an abnormality of the overlying musculature. Possible contributing factors are tightness, spasticity, adherence, or hypertrophy of the iliopsoas or iliocapsularis tendon. Anatomical features which may create a predilection to this disorder include abnormal angulation of the tendon, a large femoral head, or high femoral anteversion. We have theorized that when these lesions require surgical intervention, tenotomy of the iliopsoas at the level of the hip joint may be a useful adjunct to debridement or repair of the labrum. Further evidence is required to support this theory, and a follow-up study is currently underway at our institution to report the prospectively collected results of the technique.

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