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Review of the Iliocapsularis Muscle and its Clinical Relevance

Tomonori Sato[1], **Naomi Sato**[2*], **and Kohji Sato**[3]

[1]*Department of Physical Therapy, Tokoha University, Shizuoka, Japan*

[2]*Department of Nursing, Hamamatsu University School of Medicine, Hamamatsu, Japan*

[3]*Department of Anatomy and Neuroscience, Hamamatsu University School of Medicine, Hamamatsu, Japan*

[*]**Corresponding author:** Dr. Naomi Sato, Department of Nursing, Hamamatsu University School of Medicine, 1-20-1 Handayama, Higashi-ku, Hamamatsu, Japan, Tel: 81-53-435-2825; E-mail: naomi25@hama-med.ac.jp

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Abstract

Little is known about the iliocapsularis muscle, which covers the anteromedial capsule of the hip joint. Although this muscle has rarely mentioned in anatomy texts since its first appearance in a French Anatomy text in 1843, it is considered an important muscular landmark in terms of surgery. More recently, several studies have focused on and described the morphology and possible role of this muscle. Knowledge about the iliocapsularis muscle is essential to understand its anatomy, functions, and pathology, all of which will help to improve the management of hip conditions. Therefore, this article reviews the existing knowledge about the iliocapsularis muscle, including a presentation of the muscle dissected from a Japanese cadaver. We will further discuss the clinical importance of the anatomy of this muscle from the perspective of conservative treatment.

Keywords: Hip; Iliocapsularis; Muscle; Function

Introduction

The iliocapsularis muscle, also referred as the iliacus minor or ilio-infratrochantericus, lies deep in the body relative to the rectus femoris muscle and is not thought to vary in human beings [1,2]. This muscle has rarely mentioned in anatomy texts since its first appearance in a French Anatomy text in 1843. However, it has been considered an important muscular landmark in terms of the Bernese pericapsular osteotomy, a surgery designed to relieve hip pain and improve function in patients with symptomatic dysplastic hips.

Despite a recent focus on the iliocapsularis muscle, and descriptions of its anatomy and possible roles [1,3-5], the number of relevant studies is very limited. Furthermore, such studies have only been conducted in Europe and the United States. For these reasons, this muscle is not well described in English Anatomy texts [6-8]; furthermore, its existence is not been well recognized in non-English speaking countries, such as Japan, indicated by the lack of a Japanese name.

It is crucial for medical professionals, such as surgeon and physical therapists, who evaluate and treat patients with hip pain to have an accurate understanding of the iliocapsularis muscle because this understanding contributes to an understanding of the relevant anatomy, function, and pathology. In this article, we describe the iliocapsularis muscle through a review of its anatomy and possible roles, and discuss the clinical relevance of this muscle from perspective of conservative treatment.

Anatomy and Functions

Anatomy

Previous descriptions of the iliocapsularis muscle are presented in Table 1. The iliocapsularis muscle originates from the inferior border of the anterior inferior iliac spine (AIIS) and the anteromedial hip capsule and inserts approximately 1.5 cm distal to the lesser trochanter [2-5]. This muscle lies under the rectus femoris and to the lateral right of the iliacus. Figure 1 shows a distal portion of iliocapsularis muscle, dissected from a Japanese male cadaver (age 79, height 149 cm, weight 55 kg), particularly. The direction of fiber is from anterolateral proximally to posteromedial distally. The iliocapsularis muscle sometimes cannot be separated from the iliacus. Therefore, it can be considered to be a part of the iliacus [1]. Our dissection did not show a distinct investing fascia between the iliocapsularis muscle and the iliacus (Figure 1). Furthermore, the study by Satoh revealed that the iliocapsularis muscle was innervated by a branch of the femoral nerve, although it was performed on animals, Macaques [9]. These findings may support the iliocapsularis muscle being a part of the iliacus muscle.

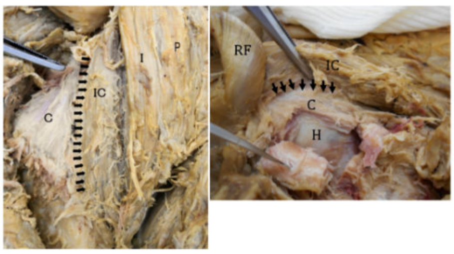

Figure 1: Cadaveric demonstration of the iliocapsularis muscle (IC) from a Japanese specimen. An anterior view of the right hip is shown in the image (left). (C)=joint capsule covered by ligament; (I)=iliacus muscle; (IC)=iliocapsularis muscle; (P)=psoas muscle. Arrow indicates the lateral margin of IC. Lateral view of the right hip is shown (right). (H)=head of femur; (RF)=rectus femoris muscle. The arrow indicates the capsular attachment of the IC.

Author	Description
Ward et al. [2]	Studied 20 fresh cadavers Origin: anteromedial capsule and inferior border of the anterior inferior iliac spine (AIIS). Insertion: 1.5 cm distal to the lesser trochanter. The measured length, width, and thickness were 1.8–2.5 cm, 1.8 cm–2.5 cm, and 0.4–1 cm, respectively.
Babst et al. [3]	Studied 421 patients with developmental dysplasia of the hip and excessive acetabular coverage using magnetic resonance imaging (MRI).
	The measured width, thickness, circumference, and cross-sectional area were 1.8-2.9 cm, 1.3-1.7 cm, 5.0-7.7 cm, and 1.5-3.0 cm^2, respectively.
Philippon et al. [20]	Studied 14 fresh cadavers.
	The authors described the origin of the iliocapsularis muscle from the inferior facet of AIIS and observed an intimate relationship between the muscle belly and the anteromedial aspect of the capsule. The footprint of the iliocapsularis muscle on AIIS was 108 mm^2.
Walters et al. [10]	Studied 11 fresh cadavers.
	Origin: Anteromedial capsule and inferior aspect of AIIS.
	Insertion: just distal to the greater trochanter.
Cooper et al. [4]	Studied 11 fresh cadavers.
	The iliocapsularis muscle had the largest capsular area for attachment.
Haefeli et al. [15]	Studied 127 subjects.
	The authors investigated the iliocapsularis-to-rectus femoris ratio with respect to the cross-sectional area, thickness, width, and circumference of each muscle. An increased iliocapsularis-to rectus femoris ratio was observed in subjects with developmental hip dysplasia.
Pourcho et al. [1]	Studied the appearance of the iliocapsularis muscle using ultrasonography, and MRI. The authors confirmed the location of the muscle under the rectus femoris, with close proximity to the anterior hip capsule.

Table 1: Studies that include descriptions of the iliocapsularis muscle.

The iliocapsularis muscle has an attachment to the anteromedial capsule of the hip [2-5,9]. Among the muscles attaching to the hip capsule such as the gluteus minimus, obturator externus, obturator internus and gemellus muscles, the iliocapsularis muscle has the largest capsular contribution (i.e., greatest dimensions) [4,10].

Only two studies have investigated the dimensions of the iliocapsularis muscle [2,3]. Ward et al. [2] performed gross anatomy dissection of 20 fresh cadavers from a European population and reported a thickness of 0.4 to 1 cm, width of 1.8 to 2.5 cm, and length of 12-13 cm. Babst et al. [3] investigated anatomic dimensions of the iliocapsularis muscle of 421 patients with developmental dysplasia of the hip and excessive acetabular coverage using magnetic resonance imaging (MRI). They reported similar dimensions in another study of cadavers from a European population. We consider two reasons why similar dimensions were observed in previous two studies. First, a European population was subjects in both studies. Second, Ward et al. used fresh cadavers, which may not have shown significant shrinkage. It has been known that embalmed tissue shrink 2.2% to 12% [11].

Blood is supplied to the iliocapsularis muscle via two arteries. One such artery is the profunda femoral artery, a branch of the femoral artery. The other is the lateral femoral circumflex artery, a branch of the profunda femoral artery [2].

The type of muscle fiber that comprises the iliocapsularis muscle is unknown. However, the psoas major muscle has been found to contain a greater percentage of fast twitch muscle fibers than slow twitch muscle fibers, whereas the iliacus may contain a large proportion of slow twitch fibers [12-14]. We speculate that the iliocapsularis muscle might also contain a greater percentage of slow twitch fibers as it has been considered to comprise a part of the iliacus muscle.

Functions

The true functions of the iliocapsularis muscle remain unknown. However, the anatomy suggests a possible role. As stated above, the iliocapsularis muscle has a direct anteromedial capsular attachment. Thereby, contraction of the iliocapsularis muscle pulls the capsule with the zona orbicularis in a superior and medial direction; this motion might tighten these structures and help stabilize the femoral head within dysplastic acetabulum [2,3,15]. As the importance of the zona orbicularis and anterior hip capsule with regard to hip stability have already been confirmed [5,16], it is highly possible that the iliocapsularis muscle contributes to hip stability through the capsule along with the zona orbicularis.

MRI-based studies have found hypertrophy of the iliocapsularis muscle (greater cross-sectional area, greater partial volume) in dysplastic hips, although this was not observed in subjects with excessive acetabular coverage [3,15]. Furthermore, Haeferi et al. [15] compared cross-sectional areas of the iliocapsularis muscle and rectus femoris muscle in patients with hip disease. These authors observed an 89% prevalence of dysplastic acetabulum if the cross-sectional area of the iliocapsularis muscle was greater than that of the rectus femoris muscle. These previous study findings suggest that the iliocapsularis muscle might provide stability for the hip joint as a possible compensatory strategy.

Studies by Andersson et al. [17,18] suggest an important role for the iliacus muscle as a stabilizer of the pelvis and hip. In their studies, selective activation of the iliacus to stabilize the pelvis in contralateral hip extension during standing was observed. Furthermore, these authors observed activation of the iliacus muscle prior to the psoas muscle, and a longer duration of iliacus contraction relative to the psoas muscle during walking. In another biomechanical study, Lewis et al. [19] investigated hip joint force using a three dimensional musculoskeletal model. The authors found that the anterior hip joint force was greater with increased hip extension, which supports the idea that an iliopsoas muscle tendon adds strength to the anterior hip joint capsule during hip extension [20-23]. Because the iliocapsularis muscle is considered to be a part of the iliacus muscle [1], these biomechanical studies [17-19] also suggest that the iliocapsularis muscle might play a role of hip stabilization.

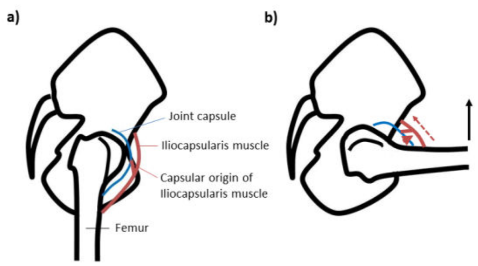

Figure 2: Diagram of a sagittal section of the hip joint showing the attachment of the iliocapsularis muscle to the capsule (a), and its retraction during active hip joint flexion (b). The arrow indicates the direction of the femur. The dotted arrow indicates the direction of the iliocapsularis muscle contraction. The arrowhead indicates the force from the capsular origin of the iliocapsularis muscle.

Several muscles attaching to the joint capsule or bursa in the hip joint or other joints, such as the intervertebral joints and knee joint, have been thought to prevent pinching of the joint capsule or bursa between joint surfaces [9,21,22]. Similarly, another possible role of the iliocapsularis muscle might be the prevention of pinching of the anteromedial part of the capsule between the femoral head and the acetabulum during hip flexion as this muscle directly attaches to the anteromedial part of the hip capsule (Figures 1 and 2).

Clinical Relevance

Hip pain is common, with the prevalence of 10-19% in the general population [24,25]. Hip pain is well known to arise from a variety of causes, such as fractures, osteoarthritis, tear in muscles, ligaments, and labrum, and impingement [26]. Among these etiologies, hip impingement is increasingly recognized as a cause of hip pain [27]. Three types of impingement can cause anterior hip pain: femoroacetabular impingement, subspine impingement, and Iliopsoas impingement [28,29]. Among these, subspine impingement has recently garnered substantial interest [30]; this condition results from a collision between the anterior femoral neck and AIIS with abnormal morphology during hip flexion. As anatomical findings now indicate that the iliocapsularis muscle inserts into AIIS, this muscle could contribute to new bone formation (e.g., osteophytes) when mechanical loading is applied through its insertional points, as dictated by Wolff's law, and could be a cause of subspine impingement. Therefore, in clinical practice, clinicians should be aware of subspine impingement as a possible cause of pain in patients complaining of anterior hip pain with hip flexion who have a history of activity requiring for repetitive hip flexion.

In addition, we consider the iliocapsularis muscle as a potential cause of capsular impingement. According to the stated "function," the iliocapsularis muscle might act to prevent capsular entrapment during hip flexion. Therefore, atrophy or weakness of this muscle may cause a loss of function and possibly lead to entrapment of the capsule between the joint surfaces.

Taken together, an understanding of the iliocapsularis muscle suggests that it could be a cause of hip pain; therefore, we must consider this among the differential diagnoses of patients with hip pain.

Conclusion

Despite receiving increasing recognition, little is known about the iliocapsularis muscle, particularly in non-English-speaking countries. An understanding of the existence of this muscle leads to studies of the precise anatomy (morphology), function, and related pathology. Therefore, such an understanding is the first step that should be taken by medical professionals who evaluate and treat patients with hip pain.

Several studies of iliocapsularis muscle have been conducted in European or American populations. We are unsure whether muscle is consistently present among members of Japanese populations or whether it would be of a similar size when compared with previous studies of European or American populations, although we were able to provide a representative iliocapsularis muscle specimen. Future studies are needed to determine whether the iliocapsularis muscle exists in Japanese populations and if so, whether it differs in size relative to previous studies.

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