Case Report

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Is the iliocapsularis muscle ubiquitous and consistent?

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Abstract

The iliocapsularis muscle has been defined as originating from anterior superior iliac spine and iliac fossa and inserting into the lesser trochanter. Dissection of twenty-nine cadaveric hips yielded five iliocapsularis muscles, with two novel variations. Prevalence of iliocapsularis was found to be 17.2%. Iliocapsularis is important during dynamic hip stabilization and its role in preventing impingement of the anterior hip capsule. Therefore, understanding the current variations and prevalence may improve our understanding of the role of this muscle and its impact in the efficacy of surgical procedures in the area. The decreased prevalence of iliocapsularis muscles in the current study, the two variants, and the clinical significance is discussed.

Keywords: hip; iliocapsularis; iliotrochantericus

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Introduction

The iliocapsularis muscle, also known as the iliotrochantericus, when present, has been reported to act as a hip flexor, located deep to rectus femoris and iliacus positioned over the anterior medial hip capsule. The iliocapsularis muscle has been described as having a proximal attachment from inferior to anterior superior iliac spine (ASIS) and anteromedial hip capsule with a common distal attachment accompanying the iliopsoas at the lesser trochanter.[1–3] Prevalence of this muscle has been reported in humans to range from 71–100%. Plante et al.[4] dissected 14 hips, 10 of which an iliocapsularis muscle was found present deep to the iliacus. Elvan et al.[5] discovered that 92% of 21 fetuses dissected contained an iliocapsularis muscle, and further considered this a common muscle. The iliacus and iliocapsularis muscles were described as having a distinct fascial layer separating the two muscles, as seen in 34 out of 39 hips, while in contrast, the other 5 hips did not show a clear fascial separation between the two muscles.[2,5]

The understanding of iliocapsularis muscle as an individual muscle has been challenged by D'Costa (2008) and Sato (2016). Sato et al.[6] showed that iliocapsularis muscle may actually be a deep slip of the iliacus if there was not a layer of investing fascia to distinctly separate the muscle from the iliacus. The innervation of iliocapsularis muscle has been demonstrated in macaques as coming from a branch of the femoral nerve entering from the upper surface of this muscle after piercing the iliacus.[7] Similarly, in human fetuses, the innervation to iliocapsularis muscle was also described as a thin nerve branch from the femoral nerve, piercing through iliacus and superficially innervating iliocapsularis muscle.[5]

The iliocapsularis muscle has been shown to be present in embryological development by Elvan et al.[5] beginning as early as 26 weeks' gestation lateral to the iliopsoas and deep to the rectus femoris. The most common proximal attachments of the muscle were observed just below the common tendon attachment for rectus femoris or on the anteromedial part of the hip joint capsule. Innervation of the iliocapsularis muscle was found to be from a small branch of the femoral nerve.

The conflicting information and ambiguity regarding the iliocapsularis muscle created a drive for further exploration in order to understand the iliocapsularis muscle's function and possible implications in hip pathology. The aim of this study was to gather clinically significant information on the variations of the iliocapsularis muscle. Knowledge of hip anatomic variations was crucial to understanding hip pathology, determining

differential diagnoses, and to more accurately develop a plan of care in symptomatic hips.

Case Report

During routine dissection of 29 hips of human adult cadavers in the anatomy laboratory, five iliocapsularis muscles were found. Three of the iliocapsularis muscles matched previous descriptions in the literature, with only one displaying innervation provided by a primary branch of the femoral nerve that passed through the belly of the iliacus, and the other two of the muscles were variations of iliocapsularis muscle.[1] Each variant iliocapsularis muscle was found to lie in a fascial compartment that was separate and distinct from the iliacus. In the present study, all of the iliocapsularis muscles had the commonality of being positioned directly beneath the iliopsoas immediately anterior to the femoral-acetabular joint. However, the two variations exhibited differences in their attachments as well as differences in their position along the hip joint. Although there was great ambiguity regarding the prevalence, function, and clinical significance of the iliocapsularis muscle; the authors are not aware of any human variations that match the variant iliocapsularis muscles described in the current cases.

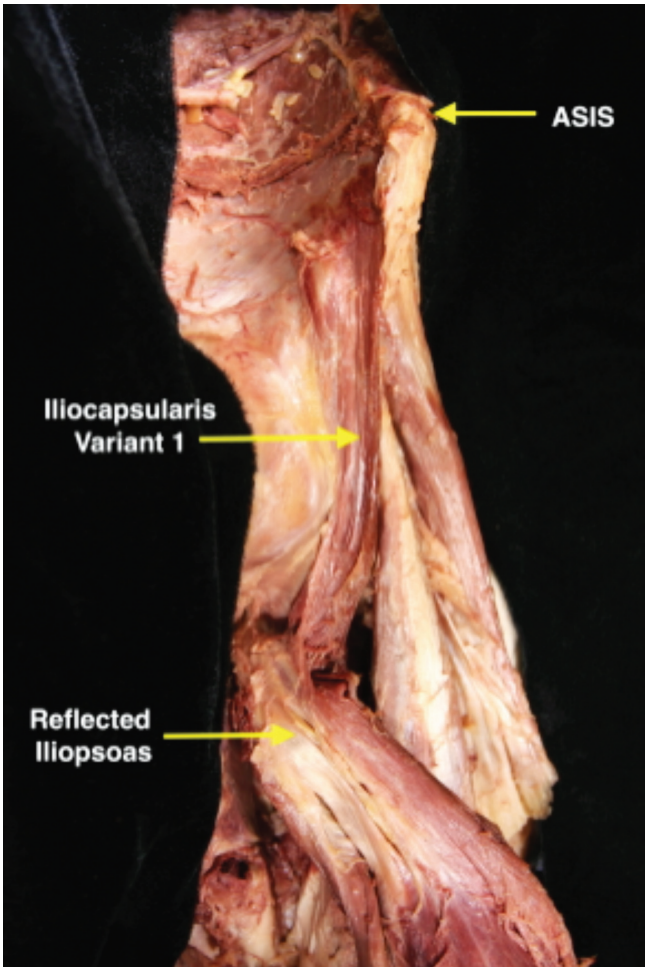

Figure 1. Photograph of anterior aspect of the left hip and thigh demonstrating unique twist of iliocapsularis muscle belly, as discussed in case 1.

Case 1

The iliocapsularis muscle in case one was identified in its own fascial compartment of the left hip, deep to the iliacus muscle. The proximal attachment arose from the ilium between the ASIS and anterior inferior iliac spine (AIIS). The muscle belly blended into the iliacus muscle, and the distal attachment inserted into the lesser trochanter along with the iliopsoas tendon. In this case, the muscle displayed a unique twist that resulted in a ribbon-like appearance of the muscle belly as it traversed toward its distal attachment. Along its course, deep fibers from the iliocapsularis muscle blended with the anterior hip capsule (**Figure 1**).

Case 2

The iliocapsularis muscle in case two was also located in its own fascial compartment of the right hip, deep to the iliacus muscle. The proximal attachment arose from a point on the iliac fossa just medial to ASIS. The muscle fibers blended with the anterior aspect of the hip capsule. After crossing the joint capsule, the belly of the iliocapsularis muscle bifurcated into medial and lateral bands. The lateral band blended into the vastus intermedius muscle while the medial band joined the common iliopsoas tendon inserting into the lesser tubercle (**Figure 2**).

Discussion

The varying descriptions of the iliocapsularis muscle in humans, and questionable function may contribute to the general ambiguity of this muscle. One purpose of this study was to determine if this muscle is indeed consistent in humans. To determine prevalence, this would require a working definition of what classifies the iliocapsularis as a muscle. As a guideline, the authors have defined iliocapsularis muscle as completely separated from iliopsoas by a fascial layer, had an origin on the iliac fossa or medial to AIIS, inserts into the lesser trochanter and intertrochanteric line, and was seen to be innervated by a first order nerve off of the femoral nerve.[8] Unlike previous claims that this muscle was constant in all humans,[1] the prevalence of iliocapsularis muscle in this study was found to be 17.2%, concluding that this muscle was not constant in all humans. With only five ilio-

capsularis muscles present in this study, and two of them being variations from what is described as typical, the authors speculate that the actual prevalence of iliocapsularis muscle was much lower than previously reported. Elvan et. al. described five iliocapsularis muscles that did not have a clear fascial layer separating the iliocapsularis muscle from the iliacus.[5] Taking into account the work of Sato and the definition of the iliocapsularis muscle, then Elvan's 92% prevalence rate would be decreased to 87% in human fetuses.[5,6]

The innervation of the iliocapsularis muscle has previously been described in human fetuses and macaques;[5,7] but rarely, if ever, in adult cadavers. Of the five muscles found during this study, one presents as a typically defined iliocapsularis muscle with innervation by a branch of the femoral nerve after piercing through the iliacus. This innervation course was similar to what is described in macaques by Satoh and in human fetuses by Elvan.[5,7] The research was not clear if the innervation provides a motor component to iliocapsularis muscle or was purely sensory. Regardless, proposed functions of the iliocapsularis muscle would lend to the assumption that there was an important motor component to the innervation to the iliocapsularis muscle.

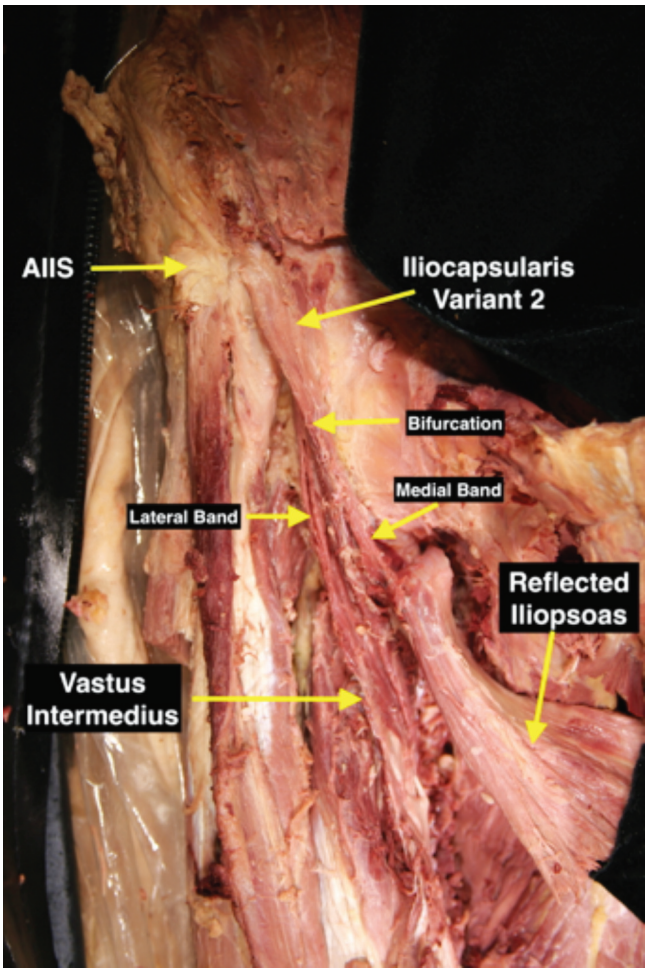

Figure 2. Photograph of anterior aspect of the right hip and thigh demonstrating variant bifurcation with medial and lateral bands, as discussed in case 2.

Limitations in the current study were that cadavers were used, and in vivo function of this muscle could not be completed. For this purpose, future research will include diagnostic ultrasound imaging and EMG to confirm the hypothesized studies. Another limitation of this study in addressing prevalence was the lack of identifying innervation. We only discovered innervation in one out of five iliocapsularis muscles in this present study, however, more careful dissection techniques should be implemented in further studies to clearly define iliocapsularis muscle as a distinct and separate muscle with intact innervation.

Functions of the iliocapsularis muscle were largely unknown.[9] The authors discussed how the anatomy of the muscle might influence the function. The iliocapsularis muscle's direct attachment to the anterior hip capsule, as described in this report as well as previous reports, implied that the muscle plays a role in pulling the capsule away from the hip joint during hip flexion. This would aid in preventing anterior synovial impingement during hip flexion exceeding 90 degrees.[3,10] In the absence of iliocapsularis muscle, increased incidence of synovial hip impingement was likely, and must be considered during the differential diagnosis of hip pathology. Iliocapsularis muscle has also been postulated to aid in hip stability.[1,2,10] The iliocapsularis muscle is commonly presented as hypertrophied in dysplastic hips, leading to assumptions that it actively contributed to anterior hip stabilization versus passive form closure that has been seen in a non-pathologic hip joint.[1]

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Conflict of Interest

The authors declare that they have no conflicts of interest.

Author Contributions

DWC: dissections, manuscript writing; ALP: dissections, project development, manuscript writing; JRG: dissec-

tions, project development, manuscript writing; PAF: manuscript writing/editing.

Ethics Approval

Compliant with all institutional guidelines per the PCOM IRB, Code of Federal Regulations (CFR)-45 CFR Part 46 as well as with the Declaration of Helsinki, the Belmont Report and the Nuremberg Code.

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