

Intermuscular Fusion Between the Psoas Major and Iliacus Muscles: Anatomical and Histological Study

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Abstract

Introduction: The term iliopsoas has recently been questioned because some anatomical studies have revealed that the psoas major and iliacus have separate distal insertions. Additionally, some older anatomical references mention a more proximal intermuscular fusion. The aim of the present study was to elucidate this anatomy in greater detail and to verify the site of fusion between the iliacus and psoas major.

Methods: Eighty human adult anatomical donors (160 sides) underwent dissection of the psoas major and iliacus muscles in the abdomen and thigh. The relationships between the two muscles and their point of fusion were documented, and the findings were classified.

Results: There was intermuscular fusion between the iliacus and psoas major muscles on all sides. The fusion was distributed as follows: 73 (45.6%) of the muscles fused proximally to the inguinal ligament (type I), 81 (50.6%) fused beneath that ligament (type II), and six (3.8%) (type III) fused distally to it. No sex-based differences were identified, while a significant side asymmetry was observed. Histologically, fascicular blending of psoas major and iliacus across a shared tendon-forming interface was seen. Additionally, connective tissue interdigitation and progressive interfiber continuity between these muscles were observed.

Conclusions: Fusion between the iliacus and psoas major muscles was universal, justifying the continued use of the term "iliopsoas." These muscles should therefore be considered a single functional unit regardless of their attachment to the femur. Our study indicates that in most cases, the iliacus and psoas major muscles fuse at or proximally to the inguinal ligament.

Introduction

The most powerful flexor of the hip is the long-described conjoint muscle, the iliopsoas, a combination of the psoas major and iliacus [20]. Some authors have argued that the two muscles constitute a single muscle with a double origin. For example, as early as 1834, Cruveilhier and Bourguery each referred to the "psoas-iliaque" muscle because of the "common" insertion on the lesser trochanter of the femur [2, 3]. To emphasize the synergy between these two muscles, some have used the term "iliopsoas musculotendinous unit" [4]. Electromyographically, the psoas major and iliacus have a common activation pattern as shown by Andersson et al. [5].

Regarding the union of these muscles, most studies have evaluated their insertion patterns on and near the lesser trochanter of the femur [6, 7]. However, a few authors [8] have identified a muscular fusion within a defined pelvic region, e.g., below the pelvic brim or at the inferior sacroiliac joint, providing a strong basis for describing the iliopsoas as a truly fused musculotendinous unit.

In the present study, we dissected human anatomical donors to elucidate the anatomy in greater detail and to determine the prevalence of a conjoined musculotendinous attachment between the psoas major

and iliacus.

Materials and Methods

During routine dissection of the hip regions of 80 human anatomical donors (160 sides) (mean age at death 81 years; range 45–103 years), the iliacus and psoas major on the proximal femur were exposed. Forty-four donors were male, and 36 were female. The inguinal ligament, the psoas major and iliacus muscle bellies were splayed apart to assess whether the muscle fibers were fused even when the two tendons appeared to be separate.

A tendon was considered fused if there was evidence of the fibers of one muscle crossing and either joining the belly of the other or being continuous with its tendon. If the muscle or tendinous fibers were fused, the height of the fusion point was categorized as proximal to the inguinal ligament (type I), beneath the inguinal ligament (type II), or distal to the inguinal ligament (type III) (Fig. 1).

Two muscle samples from each type were examined histologically using Masson's trichrome staining.

Categorical data describing the location of intermuscular fusion (type I–III) were summarized as frequencies and percentages. Associations between fusion type and sex, as well as fusion type and laterality (right vs. left), were evaluated using the chi-square test of independence. When expected cell counts were less than 5, Fisher's exact test was used as appropriate. Statistical significance was set at $p < 0.05$. All analyses were performed using standard statistical software (e.g., SPSS version 32.0.0, IBM Corp., Armonk, NY, USA).

The authors state that every effort was made to comply with all local and international ethical guidelines and laws governing the use of human anatomical donors and their images in anatomical research [9–12]. The protocol of the study did not require approval by the ethical committees or informed consent. The study followed the Declaration of Helsinki (64th WMA General Assembly, Fortaleza, Brazil, October 2013).

Results

The psoas and iliacus tendons were fused in all 80 anatomical donors (160 sides). The psoas and iliacus muscles appeared to have discrete tendons, but when examined more closely, they all had muscle and/or tendinous fibers crossing between them to form what we deemed a fused tendon. The location of fusion varied: 73 sides (45.6%) fused proximal to the inguinal ligament (type I), 81 sides (50.6%) fused beneath the inguinal ligament (type II), and six sides (3.8%) fused distal to the inguinal ligament (type III) (Fig. 2).

Among 88 male lower limbs, 40 fused proximal to the inguinal ligament (type I), 45 fused beneath the ligament (type II), and three fused distally (type III). Among 72 female lower limbs, 33 fused proximal to

the inguinal ligament (type I), 36 fused beneath the ligament (type II), and three fused distally (type III). There was no statistically significant association between sex and fusion type ($\chi^2 = 0.06$, $df = 2$, $p = 0.97$).

We also examined whether fusion location differed by side. Among 80 right lower limbs, 44 fused proximal to the inguinal ligament (type I), 36 fused beneath the ligament (type II), and none fused distally (type III). Among 80 left lower limbs, 29 fused proximal to the inguinal ligament (type I), 45 fused beneath the ligament (type II), and six fused distally (type III). There was a statistically significant difference in the distribution of fusion types between right and left sides ($\chi^2 = 9.84$, $df = 2$, $p = 0.007$), driven primarily by the absence of type III fusion on the right and its exclusive occurrence on the left.

Histologically, Masson's trichrome staining of the psoas–iliacus region consistently demonstrated a prominent zone of intermuscular fusion characterized by dense, tendon-like collagenous connective tissue uniting the two muscles. At low magnification (Fig. 3), the psoas major and iliacus did not appear as fully segregated muscular compartments but instead converged toward a central, continuous band of blue-staining collagen. This band was substantially thicker and more coherent than ordinary epimysial fascia and received direct muscular contributions from both sides, indicating that the interface between the two muscles is structurally integrated rather than partitioned by a discrete fascial septum. At intermediate magnification (Fig. 3), the fusion zone revealed its internal organization, consisting of densely packed, longitudinally oriented collagen fibers that displayed the linear alignment characteristic of tendon. Muscle fibers from both the psoas major and iliacus interdigitated with this collagen mass, terminating along its margin in a pattern more consistent with tendon formation than with independent aponeurotic insertions. High magnification (Fig. 3) further confirmed the tendon-like nature of this intermuscular bridge. The collagen fibers formed compact, parallel bundles separated by thin laminae, typical of early tendon differentiation. Small islands of muscle were visible along the periphery where fascicles appeared to insert directly into the collagen.

Discussion

Grossly, our anatomical study showed that the psoas major and iliacus are normally fused before their insertion into the lesser trochanter of the femur. Most of the fusions occurred at or proximal to the inguinal ligament. Histologically, our findings demonstrated that the psoas major and iliacus muscles share a structurally integrated connective tissue fusion zone well proximal to their final insertion on the lesser trochanter. Rather than functioning as two completely independent muscles with distinct tendons, they form a common tendon-like structure, supporting the concept of a unified iliopsoas complex.

Distal insertional fusion

According to some literature, the lateral fibers of the iliacus muscle insert into the lateral side of the psoas major tendon, forming what is referred to as an "iliopsoas tendon" [13]. Gray further stated that this iliopsoas tendon inserts on the superior aspect of the lesser trochanter of the femur, with additional fibers from the iliacus continuing in front of the lesser trochanter and inserting slightly below it [8].

According to the study by Sedlmayr et al. (2022), the tendinous components of the psoas major and iliacus remain independent [14]. Their examination of 17 anatomical donors demonstrated that the psoas major tendon inserts exclusively on the lesser trochanter, whereas the iliacus tendon occupies the anterior surface of the lesser trochanter; there is no confluence between the tendons. However, most recent literature makes no distinction between the psoas major and iliacus insertion points, describing a single iliopsoas insertion point on the superior aspect of the lesser trochanter.

Proximal intermuscular fusion

Some older literature mentioned a more proximal intermuscular fusion between the iliacus and psoas major. For example, Winslow described the two muscles as fusing by a few fleshy fibers before they exited the abdomen [15]. This author stated that the fibers of the iliacus unite with the lower part of the psoas major by a "kind of aponeurosis" distal to the lesser trochanter of the femur.

Cruveilhier stated, "The fleshy fibers converge and are immediately attached to the external edge of the common tendon, which we have described as originating in the substance of the psoas [2]. This tendon which receives on its inner side all the fibers of the psoas and even those fibers of the iliacus which arise from the brim of the pelvis, runs along the side of the brim, diminishing its transverse diameter and emerges from the pelvis under the crural arch passing through a remarkable groove between the anterior inferior spinous process of the ilium and the iliopectineal eminence. In this situation, all the fibers of the psoas terminate. Those that remain of the iliacus are successively attached to the outer side of the tendon like the barbs of a feather to the shaft and form a triangular fleshy bundle which immediately changes its direction passes backward inward and downward among the muscles of the thigh it turns slightly round so that its anterior surface looks somewhat inward and its posterior surface outward and is inserted into the lesser trochanter which it embraces on every side even to its base."

Several modern anatomical and radiological sources describe the iliacus and psoas major as fusing within the pelvis rather than merely sharing a distal tendon. Radiological anatomy provides some of the clearest statements. For example, the Radsource MSK imaging review reported that the psoas and iliacus muscles "variably fuse below the pelvic brim," placing the fusion zone squarely inside the pelvic cavity as the combined muscle transitions toward the muscular lacuna beneath the inguinal ligament [16]. Pelvic radiotherapy contouring guidelines similarly note that the fusion between the psoas major and iliacus "begins at the bottom of the sacroiliac joint" [17]. Other sources describe the psoas major as fusing with the iliacus at the L5–S2 levels, corresponding to the posterior abdominal wall–pelvic inlet transition, reinforcing the idea of a proximal pelvic intermuscular fusion rather than a purely distal confluence [18]. Barriga et al. describe the psoas major as fusing with the iliacus before insertion on the lesser trochanter, implying a fusion zone located deep to the inguinal ligament and within the pelvic outlet [19]. Wong et al. similarly state that the psoas major "fuses with the iliacus deep to the inguinal ligament," an anatomical position continuous with the lesser pelvis [20]. The MRI literature further supports the fusion concept by describing partial separation of the psoas tendon as representing "incomplete fusion of the iliacus and psoas major" at the level of the hip joint [21]. In contrast, studies

focusing on the distal insertion emphasize tendinous merging near the hip rather than muscular fusion in the pelvis. For example, Philippon et al. describe the merging of the medial iliacus tendon with the psoas tendon at the femoral level [6, 7]. Likewise, Polster et al. demonstrated tendinous fibers crossing from the lateral aspect of the iliacus to the psoas major near the femoral head, and stated that these formed the iliopsoas tendon [22].

Conclusion

In the present study, there was always fusion between the iliacus and psoas major muscles, justifying the continued use of the term 'iliopsoas.' Therefore, these muscles should be considered a single functional unit regardless of their attachment to the femur. Our study showed that most of the iliacus and psoas major muscles fuse at or proximal to the inguinal ligament.

Declarations

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Ethical declarations

The protocol of the study did not require approval by the ethical committees or informed consent. The study followed the Declaration of Helsinki (64th WMA General Assembly, Fortaleza, Brazil, October 2013).

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Figures

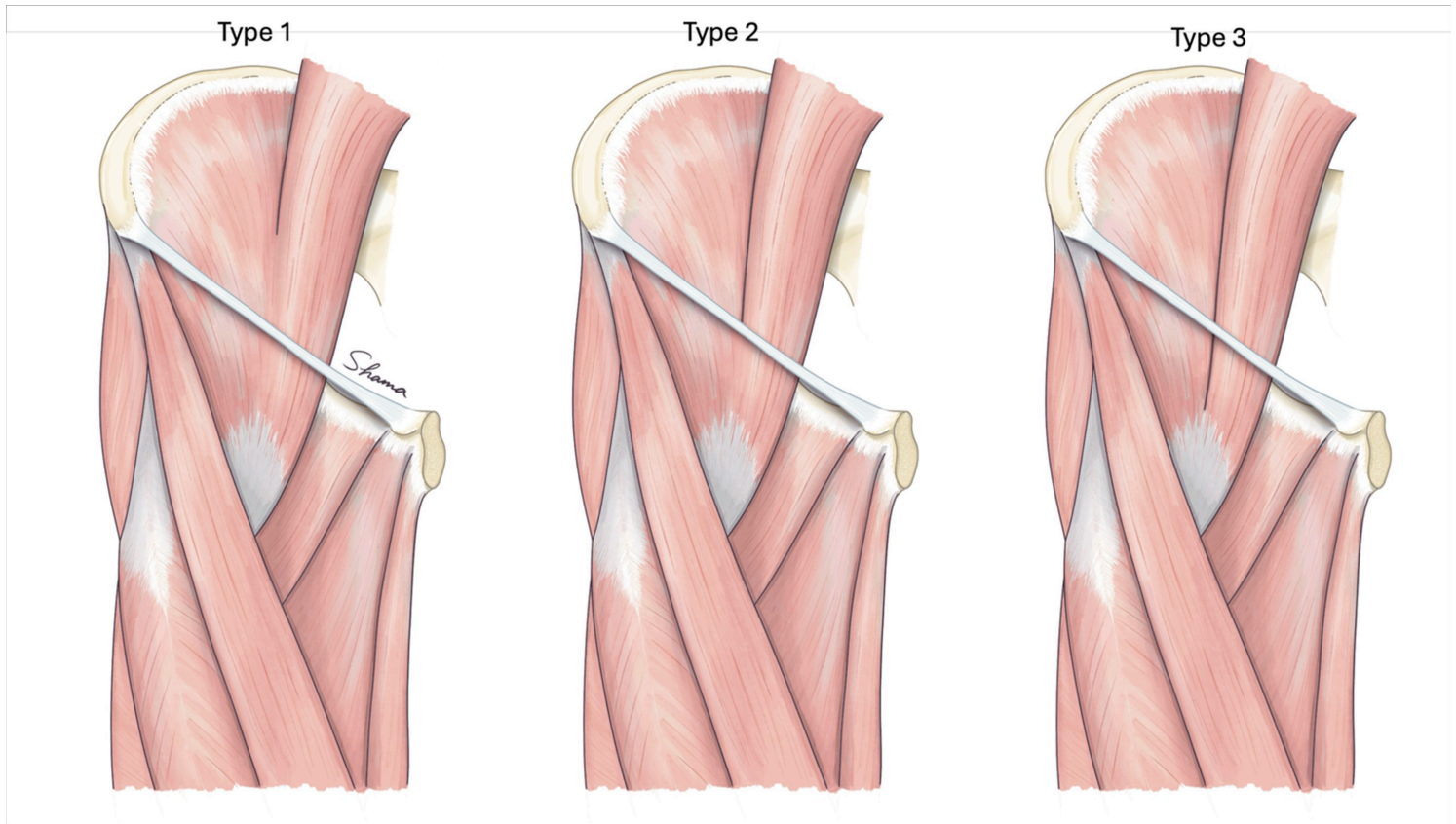


Figure 1

Sequential drawings illustrating three morphological configurations of psoas–iliacus integration relative to the inguinal ligament. Left: Type I, a broad fascicular convergence of the psoas major and iliacus superior to the inguinal ligament, forming a unified tendon-like structure before entering the pelvis. Middle: Type II, fusion at the level of the inguinal ligament, with visible interdigitation of muscle fibers at the point of passage beneath the ligament. Right: Type III, fusion distal to the inguinal ligament, where the iliacus maintains a separate fascicular identity until the two muscles merge inferior to the ligamentous margin. These highlight the variable topography of psoas–iliacus blending along the anterior hip. Original illustration created by the authors. © 2026 IT Clinical Anatomy Research Lab. Used with permission.



Figure 2

Anatomical donor examples of fusion types 1-3. Type I (left): early union of psoas major with iliacus proximal to the inguinal ligament. Type II (center): fiber convergence directly at the level of the inguinal ligament. Type III (right): preservation of muscular separation above the ligament with fusion inferior to the ligament.

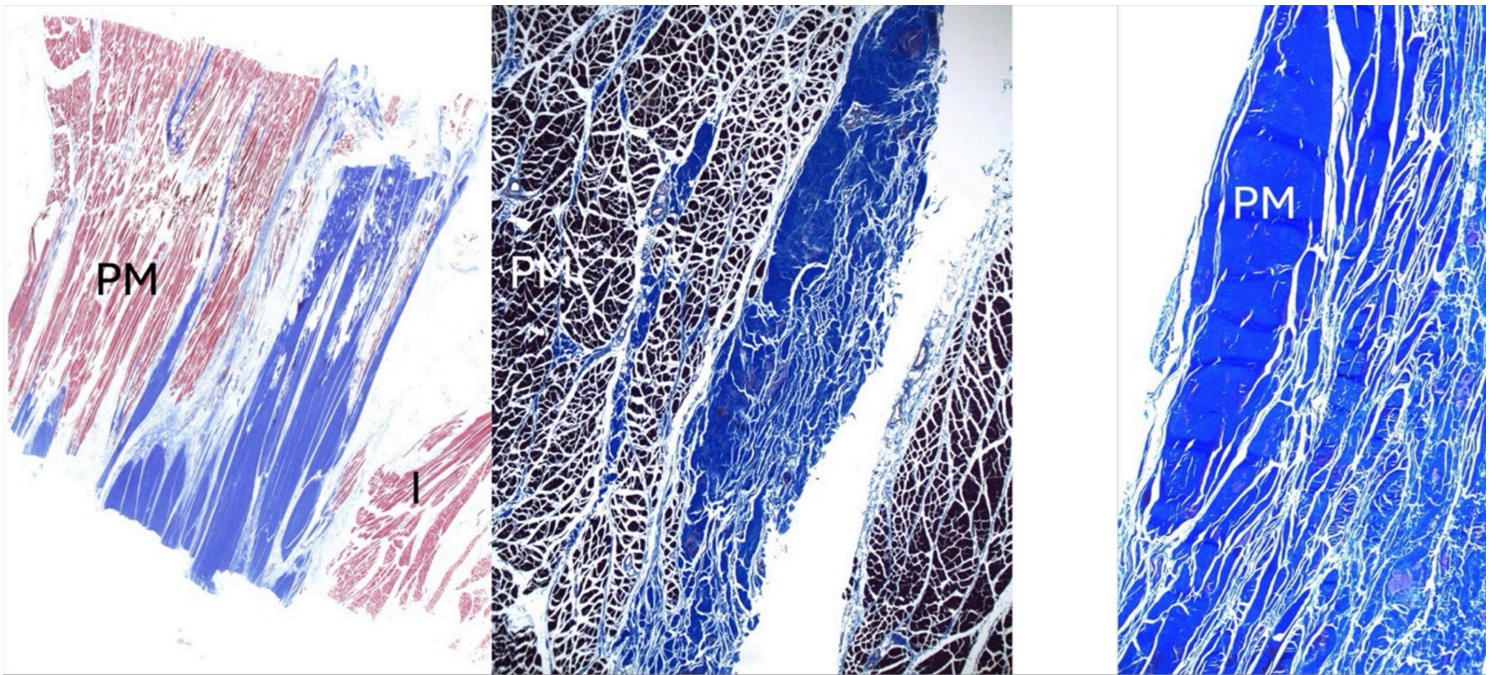


Figure 3

Histological views demonstrating structural continuity between psoas major (PM) and iliacus (I). Left panel: coronal section, low magnification, showing fascicular blending of PM (red-stained fibers) with I across a shared tendon-forming interface (blue-stained connective components). Middle and right panels: axial sections through the intertendinous region, illustrating connective tissue interdigitation and progressive interfiber continuity between PM and I. These sections confirm the anatomical fusion patterns visualized during dissection and modeled in the schematic illustrations.