Vinson *et al.*
Bulletin of the National Research Centre (2023) 47:35
https://doi.org/10.1186/s42269-023-01010-3

Bulletin of the National Research Centre

CASE REPORT

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Variant femoral nerve: the path beneath the iliacus muscle and into neuropathic symptoms

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Abstract

Background Previous discussions regarding variant femoral nerves often report an aberrant slip of a small portion of the iliacus muscle as a common cause of the femoral nerve splitting. Within these reported cases, the variant path involves a small amount of the nerve and treatment often involves surgical intervention to relieve nerve entrapment. Only a few cases have been reported that were not secondary to an aberrant muscle slippage, none of which include the variant discussed below.

Case presentation A Caucasian male cadaver in his 70 s was discovered to have a variant femoral nerve upon dissection and evaluation of the pelvic region, without evidence of muscle slippage or surgical intervention. The bulk of the nerve pierced and traveled deep within the iliacus muscle before emerging distal to the pubic eminence and merging with the smaller portion that continued with the native course anteriorly. This variation would result in a predisposition to nerve compression during hip flexion and knee extension, with subsequent patient concerns of muscle weakness and sensory loss of unknown origins.

Conclusion Awareness of this atypical variation could provide clinicians with another potential diagnosis to consider when managing femoral neuropathy, as well as the rationale for a noninvasive treatment option.

Keywords Muscle slip, Nerve variant, Hip flexion, Compressive neuropathy, Counterstrain, Case report

Background

Originating from the lumbar plexus, the typical course of the femoral nerve descends anterior to the iliacus, travels deep to the inguinal ligament, and then branches into anterior and posterior divisions responsible for innervating anterior thigh muscles (Fig. 1). Clinically, the spatial relationship of the iliopsoas complex and the femoral nerve has been described as an "entrapment-risk", most often following medical or surgical interventions (Park et al. 2020). There have been differing symptoms reported from these previously reported variations. Documented symptoms related to variant femoral nerves include thigh weakness, thigh numbness, and difficulty standing (Park et al. 2020; Vázquez et al. 2007).

Previous literature describes variations of the relationship between the femoral nerve and the iliacus as a small muscle slip splitting the femoral nerve (D'Costa et al. 2008). While this may cause some amount of nerve compression, it seems unlikely with such a small muscle belly produced from such a slippage and would require a greater degree of compressive force to result in symptoms. We present a case report of a femoral nerve variant that is distinct from previous literature due to the larger bulk of the variant nerve coursing the majority of the iliacus before emerging distal to the pubic eminence, without evidence of surgical intervention or injury as a precipitating event (Fig. 2c).

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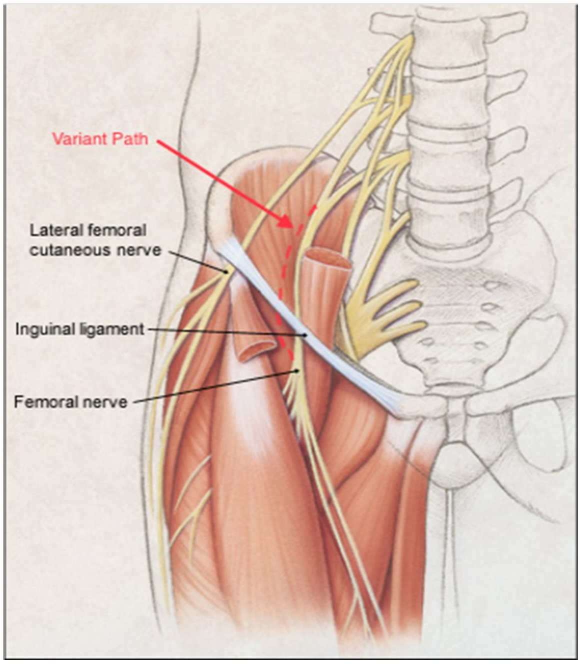

Fig. 1 Diagram of typical anatomical relationship of femoral nerve and iliacus muscle. Variant path is mapped in red

Case presentation

A Caucasian male cadaver in his 70 s, used in a first-year anatomy course for medical education, was discovered to have a variant femoral nerve upon dissection and evaluation of the pelvic region. The musculature and surrounding structures were originally left intact, with additional dissection performed from March 2021 to April 2021. The right femoral nerve originated from the lumbar plexus, descended, and then, bifurcated upon reaching the iliacus (Fig. 2a). The majority of the nerve spontaneously pierced the iliacus (Fig. 2b), leaving a smaller portion to follow the typical course anteriorly (Fig. 2c). The variant bulk traveled within the iliacus, exited inferior to the inguinal ligament and then, merged with the smaller portion of the nerve (Fig. 2d). The left femoral nerve showed no abnormalities.

This anatomic variation was not secondary to any known surgical or medical intervention, a common theme among the previously reported variations of femoral nerve splitting (Spratt et al. 1996). In context of embryologic development, the iliacus muscle is considered a skeletal muscle and therefore, undergoes development via myoblast formation and subsequent proliferation to form myocytes. While dependent on muscle regulatory gene expression for development and repair, the absence or variation of some muscles, including the iliacus, is considered common and usually of little to consequence (Moore et al. 2013).

Discussion

Compared to the previously cited aberrant muscle slips, the nerve in this donor is most likely subject to greater compressive forces between the iliacus muscle and the rigid pubic eminence during muscle contraction. Due to the unknowns within the patient's clinical history and the inability to contact next of kin, our analysis of potential manifestations is limited to interpretation of anatomical relationships. The clinical manifestation expected would be weakness of the anterior thigh muscles responsible for hip flexion and knee extension. Also expected would be sensory loss to the anteromedial thigh and the medial leg via the saphenous nerve distally. Because the compression did not involve the lateral femoral cutaneous nerve, which originates from the lumbar plexus independent of the femoral nerve, there would not be expected sensory loss to the anterolateral thigh.

The patient in this report would present with these symptoms particularly during hip flexion and knee extension activities, such as stair-climbing, bending over to dress, longer periods spent seated, and rising from a seated position. Compared to prior documented variants, this presentation involves the bulk of the femoral nerve being compressed by a larger surface area of the iliacus. The increased surface area in contact is expected to produce more frequent symptoms that would present earlier in the range of motion performed, with a larger compressive force against the pubic eminence.

Counterstrain technique is a commonly used osteopathic manipulative technique (OMT) to treat the iliopsoas complex and restore hypertrophic muscles to a normal tone by way of targeting the Golgi tendon organ in the affected muscle belly. Muscle energy is an additional osteopathic technique that involves the affected muscle or joint being passively positioned into the restrictive barrier and held in place by the provider while the patient provides an isometric muscle contraction on request. This is followed by relaxation and repeated three to five times (Eldemire and Goto 2021). It can be speculated that using counterstrain or muscle energy techniques on a patient with a femoral nerve deviation such as this one would reduce iliopsoas tension resulting in reduced femoral nerve compression at the pubic eminence.

Conclusions

We describe an anatomical variation of the femoral nerve in the pelvis that has not been previously documented in literature and is significant in that it may produce neuropathic symptoms of an unidentifiable origin in a living individual. This variant has further significance due to a larger portion of the femoral nerve remaining within the iliacus as it crosses over the

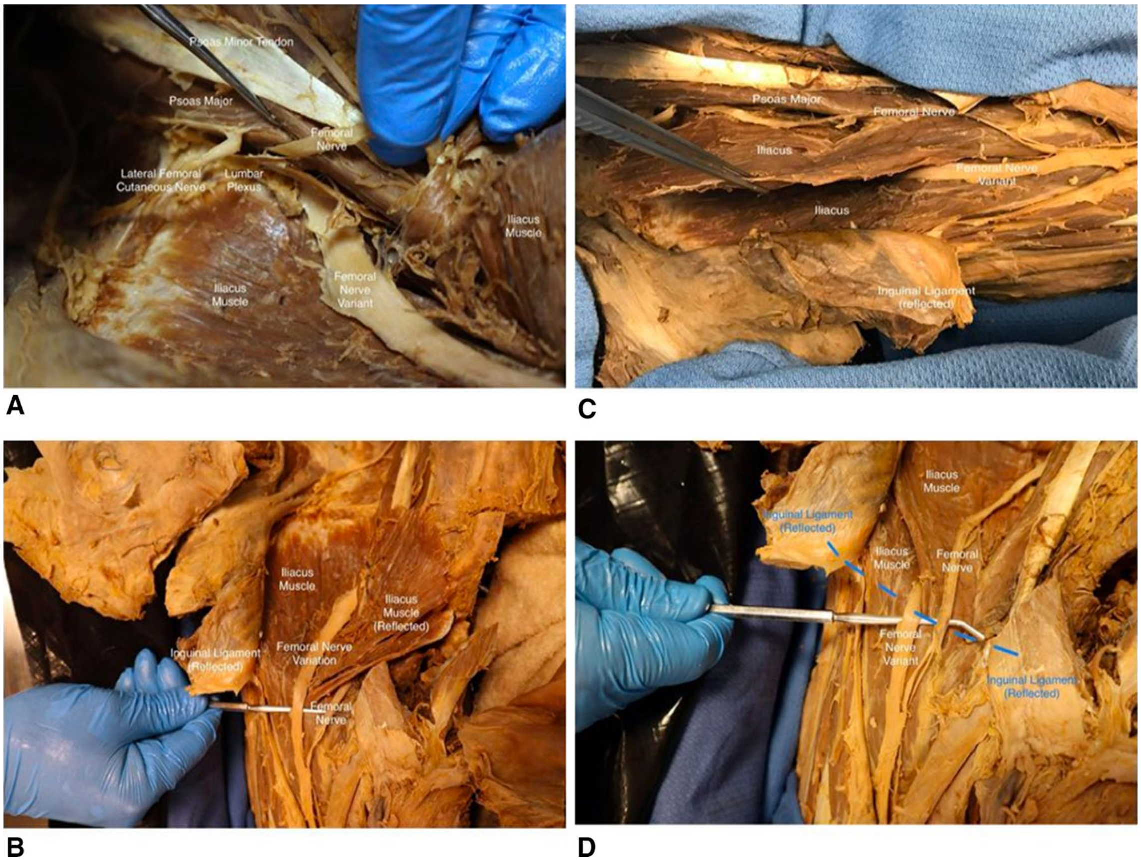

Fig. 2 **a** Right lumbar plexus showing origin of femoral nerve variant deep to the psoas major muscle, iliacus reflected to show variant femoral nerve. **b** Right femoral nerve variant piercing iliacus muscle and relationship. Inguinal ligament reflected to show merging of variant and typical femoral nerve tissue. **c** Variant femoral nerve emerging from iliacus and relationship with typical femoral nerve tract. **d** Variant femoral nerve emerging from iliacus and close association with inguinal ligament. Inguinal ligament path depicted in blue

pubic eminence and does not appear to be secondary to an etiology consistent with previous literature, i.e., an aberrant muscle slip. Given this unique distribution, the case donor would be significantly predisposed to compression of the femoral nerve against the pubic eminence during activities involving hip flexion, such as climbing stairs, bending to dress, and prolonged periods sitting.

Awareness of this type of femoral nerve variation would support the medical community in considering alternative diagnosis in patients presenting with related symptoms. Regarding the potential compressive neuropathy, there are conservative treatments that may be considered as an effective form of treatment that is financially mindful of the patient, i.e., OMT. Techniques including counterstrain to the psoas and iliacus, or muscle energy to the hip flexors could relieve (lessen) such nerve compression.

Abbreviation

SHSU–COM Sam Houston State University–College of Osteopathic Medicine

Acknowledgements

We would like to thank Dr. Amberly Reynolds, Ph.D. for her guidance on this project as well as Mr. Salcido for ensuring we had access to the lab and supplies. We are grateful for the SHSU–COM clinical department for allowing us to document this variation and use their facilities. The authors thank those who donated their bodies to science so that anatomical research could be performed and used to influence future patient care.

Author contributions

CV performed literature review of variant femoral nerves, assisted in dissection and data collection, and was a major contributor to writing the manuscript. EP performed literature review for treatment options involving variant nerve pathologies, assisted in dissection and data collection, and led the manuscript editing process. ML led the initial dissection where variation was discovered and assisted in manuscript editing. All authors read and approved the final manuscript.

Funding

Financial support awarded by the Medical Student Scholarship Program from SHSU–COM. Authors have no other relevant financial or non-financial interests to disclose.

Availability of data and materials

Data obtained from donors, without identifying information, are available upon request from the authors with the approval of SHSU–COM Department of Clinical Anatomy. The data and material in this case report were presented as a poster at Experimental Biology Annual Conference, April 2–5, 2022, in Philadelphia, PA.

Declarations

Ethics approval and consent to participate
This study was carried out in the Clinical Anatomy department of Sam Houston State University–College of Osteopathic Medicine (SHSU–COM) in Conroe, Texas by authors Colby Vinson and Ethan Pavlovsky. SHSU–COM clinical anatomy department consented to the study. IRB approval was granted by SHSU (SHSU IRB-2021–317). The donor was processed by University of Texas McGovern Medical School in Houston, Texas, and was dissected at the SHSU–COM facility from August 2020 to December 2021.

Consent for publication
The next of kin of the reported case patient was unable to be contacted for consent. All identifying information has been excluded except for age range, ethnicity, and gender.

Competing interests
Authors have no competing interests to disclose.

Received: 15 September 2022 Accepted: 27 February 2023
Published online: 06 March 2023

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