Annals of Medical and Clinical Case Reports
Volume 1| Mini Review

Anatomical Variations and Clinical Applications of The Quadratus Femoris Muscle : A Brief Review

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Citation: Guo Shuai, Anatomical Variations and Clinical Applications of the Quadratus Femoris Muscle: A Brief Review., Ann Med Clin Case Rep®, 2025; 1(3): 1-5.

Key words: Quadratus femoris; Anatomic variation; External Rotator Hip Muscle

Published Date: 07-07-2025 **Accepted Date:** 05-07-2025 **Received Date:** 30-07-2025

Abstract

The quadratus femoris is a square-shaped muscle in the hip cuff group, participating in external rotation of the hip joint and assisting in femoral adduction. The anatomical variation of this muscle is not common. This article reports a case of unilateral quadratus femoris absence and reviews the previous data on quadratus femoris variations and related clinical applications. It provides reference for professionals in anatomy, surgery, radiology and rehabilitation.

1. Introduction

The quadratus femoris is located deep to the gluteus maximus. It usually originates from the outer side of the ischial tubercle and extends outward to the femoral quadrate tubercle and the intertrochanteric crest, and is innervated by branches of the sciatic nerve [1]. The quadriceps femoris, along with the piriformis, obturator and adductor muscles, and the upper and lower twin muscles, together form the short external rotator group of the hip joint, also known as the hip rotator cuff group, which plays a crucial role in maintaining the normal movement and stability of the hip joint (Figure 1) [2, 3]. When the hip joint is extended, the quadriceps femoris is a powerful external rotator of the hip joint. When the hip joint is flexed, it enables the leg to swing outward and perform actions such as turning over to get on a horse or riding a bike. The contraction of the quadriceps femoris muscle can reduce the stress formed by the femoral neck trunk Angle and alleviate the tendency of femoral head subsidence caused by age factors. When the quadratus femoris muscle is absent or atrophied, the sciatic nerve will be deeply embedded between the ischial tuberosity and the greater trochanter of the femur. When the hip joint is externally rotated, it is easy to cause compression of this nerve [4].

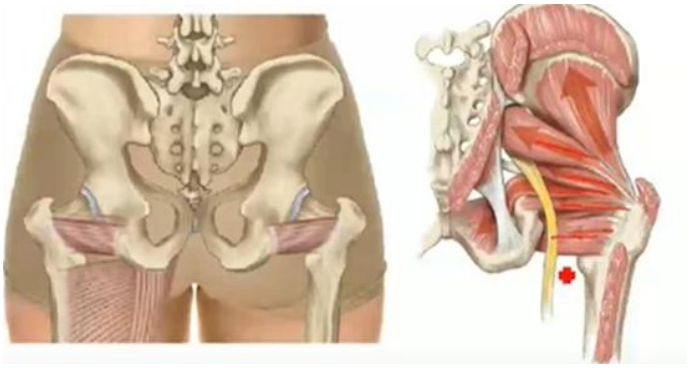

Figure 1: Schematic diagram of the normal position of the quadriceps femoris muscle

2. Anatomical Variations of The Quadratus Femoris Muscle

During the anatomical study of the deep gluteal muscle group, the authors discovered a specimen of absence of the left quadriceps femoris muscle (Figure 2). This specimen is an adult male with a normal body type. After the removal of the left gluteus maximus muscle, there was a gap between the intertrochanteric crest and the ischial tuberosity, through which the sciatic nerve trunk passed. No quadriceps femoris muscle was found. No hyperplasia or compensation was observed in the other nearby muscles. The right quadratus femoris muscle of this specimen was normally present. It indicates that this is a case of complete absence of unilateral quadriceps femoris muscle. Subsequently, we conducted a review of the relevant literature and found that there were not many reports on the absence of the quadratus femoris muscle. Zhong Shizhen et al. reported in the Journal of Anatomy in 1965 that among 268 specimens in the southwest of China, the quadorius femoris muscle was absent on 3 sides, accounting for 1.1% [5]. Zhang Zuotao reported a case of left quadratus femoris absence in 1995[6]. In 1929, the Journal of Anatomy reported a case of complete absence of the left quadratus femoris muscle [7]. In 2011, the International Journal of Anatomical Variations reported a case of bilateral quadriceps femoris and hemiembrane absence of a 73-year-old Caucasian female [8]. In 2006, the Cerrahpasa Medical School of Istanbul University reported a case of the left biceps femoris muscle [9]. The quadratus femoris muscle is homologous to the gluteal muscle during the embryonic period and occurs in the 28th to 32nd segments [6]. The causes of abnormal differentiation of the quadratus femoris muscle remain unclear. Moreover, several recorded cases of quadriceps femoris muscle variations all occurred on the left side. Whether this left-side tendency has scientific significance remains unclear. Understanding the anatomical variations of this muscle is of certain help to clinical professionals.

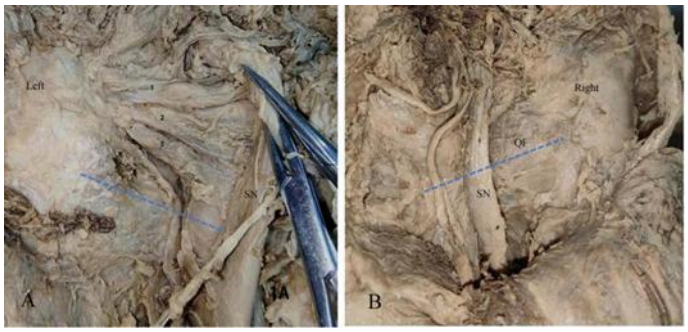

Figure 2: Deep structures of the posterior gluteal region: (A) shows the absence of the left quadriceps femoris muscle, and (B) shows the presence of the right quadriceps femoris muscle. QF: Quadratus femoris muscle, SN: Sciatic nerve

3. Biomechanical Characteristics of The Quadratus Femoris Muscle

3.1. An Unnoticed Muscle

The quadratus femoris is the lowest flat rectangular muscle in the deep gluteal muscle group. It is located on the superficial surface of the external obturator muscle, attached to the lateral side of the ischial tuberosity, and ends between the square tuberosity and the intertrochanteric crest. Below it is the upper edge of the adductor major. The fine branches of the quadratus femoris nerve originate from the sciatic nerve (L4-5, S1) and usually travel in front of this muscle. Therefore, injury to this muscle often causes pain in the

distribution area of the sciatic nerve in a referred manner. Quadratus femoris injury is a relatively common motor system disease, but it is easily misdiagnosed and ignored [10, 11].

3.2. Biomechanical Characteristics

The quadratus femoris muscle can keep the femoral head in the proper position, thereby stabilizing the hip joint. When the lower limbs are in an anatomical position, the quadratus femoris muscle participates in the external rotation of the hip joint and assists in the adduction of the femur. When the hip joint is flexed and internally rotated, the quadratus femoris muscle undergoes eccentric contraction. As one of the hip rotator cuff muscle groups, it works together with the adductor internal and external muscles, the superior and inferior twins, and the piriformis to strengthen and externally rotate the hip joint. After the quadriceps femoris muscle is injured, it can lead to instability of the hip joint. Once the gravity line reaches the lower limb, it is difficult to perform actions such as lateral twisting and bending, lifting heavy objects, or forceful rotation. If there is a problem with a certain muscle in the posterior hip group, it will cause the quadriceps femoris to compensate, thereby leading to spasticity and contraction of this muscle and creating a tight feeling in the groin at the front [12].

3.3. Simple Testing Method

When testing the quadriceps femoris muscle, the patient can be placed in a prone position. The inner side of the ischial tubercle can be touched with fingers, and it can gradually slide towards the lateral greater trochanter of the ischial bone and stop at the intertrochanteric ridge. Have the examinee externally rotate the hip joint and gently resist the palpation area to initially determine whether the muscle is abnormal [13-15].

4. Exercises To Activate The Quadriceps Femoris Muscle

4.1. Multi-Plane Lunge Squat

Forward lunge squat：Stand with feet parallel. Take a big step forward with one foot and bend the knee so that the knee and ankle joints form a 90° Angle. The rear knee joint is fully close to the ground, the upper body is upright, and the center of gravity is above the buttocks. Keep the posture still and maintain it, then switch to the other lower limb. After accumulating a certain amount of practice, trunk rotation can be appropriately increased to fully activate the gluteal muscles and external hip rotators. Based on the forward lunge squat, multi-directional lunges can be gradually developed, such as the lateral lunge squat to the sides of the body, as well as the lunge squat to the right front and left front [16].

The practice of this movement can not only enhance the core strength of the body, but mainly activate the abductor muscles of the hip joint and increase joint stability. So it can be used to stretch the quadriceps femoris muscle or for compensatory rehabilitation of the corresponding muscles [3].

4.2. Supine Hip Rotator Cuff Stretching

Lie on your back on the ground with your arms at your sides and keep your feet together. Lift the right knee joint upwards to bend the hip joint at a 90-degree Angle and keep the lower leg parallel to the ground. Hold the position and take a deep breath once, then rotate the right leg inward to the left. Maintain the maximum range of motion, stay still, then return to the original position and practice on the other side [17, 18].

5. Clinical Applications Related To The Quadratus Femoris Muscle

5.1. Ischiofemoral Impingement Syndrome (IFI)

IFI was first proposed by American radiologist Torriani in 2009 [4]. When the space between the ischial tubercle and the small trochanter narrows, the soft tissue structures such as the quadratus femoris and the sciatic nerve located in this space are compressed. After compression of the quadratus femoris muscle, edema, degeneration and atrophy occur, resulting in non-specific hip pain related to morphological abnormalities or abnormal MRI signals around the hip, which can last for several months to several years. Competitive sports athletes (such as gymnasts, dancers, race walkers, and marathon runners) are also prone to this disease as they often involve repetitive hip joint movements [2, 19]. Local skeletal muscle lesions of the hip joint and congenital dysplasia of the small trochanter can also lead to the occurrence of symptoms of IFI. IFI is easily confused with piriformis syndrome, acetabular

impaction syndrome, sacroiliac joint disorder, lumbar referred pain and other conditions. If it is not given sufficient attention in clinical practice, it is prone to misdiagnosis and is often referred to as "unknown low back pain disease"[20].

5.2 Quadratus Femoris Injury - A Muscle That Causes Pain Regardless Of Posture

Quadriceps femoris injury is common in young and middle-aged women. The main symptoms are distending pain on one side of the buttocks, accompanied by radiating pain in the lower limbs [21, 22]. The pain cannot be relieved by bed rest and may even worsen. The patient often fidgets and needs to constantly change positions. Sometimes it is extremely similar to the pain caused by lumbar intervertebral disc protrusion, which can easily lead to misdiagnosis [11, 12]. The pain at the trigger point on the lateral edge of the ischial tubercle is an extremely important differentiating point [23]. In addition, during hip replacement surgeries caused by various reasons, it is also necessary to enhance the protection of the short external rotator muscles of the hip joint to avoid affecting the normal movement and stability of the hip joint.

5.3. Quadriceps Femoris Muscle Pedicle Bone Flap Transplantation

The quadriceps femoris works in conjunction with other external rotator muscles to externally rotate the hip joint and is also the abductor muscle when the hip joint is flexed. Femoral muscle bone flap on the femoral side is a bone flap with dual blood supply from burdock and vascular pedicle. The blood supply is abundant and the length of the pedicle is sufficient. The quadratus femoris muscle receives blood supplies from the inferior gluteal artery, the medial femoral artery and the lateral femoral artery, and has a very rich collateral circulation [1]. These characteristics have laid an anatomical foundation for the application of the femoral muscle bone flap in the treatment of diseases such as avascular necrosis of the femoral head and femoral neck fractures combined with posterior bone comminution and collapse [24, 25].

6. Summary

The quadratus femoris is an important component of the hip joint stabilizing muscle group. It is located deep in the buttocks and is not easily noticed. There are not many reports on the congenital variations of the quadratus femoris muscle, but the variations exist in various forms. This article reports a specimen of absence of the left quadratus femoris muscle and introduces the biomechanics and clinical applications of the quadratus femoris muscle, providing a reference for practitioners in radiology, surgery, rehabilitation and sports.

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