# Anatomical Basis for the Selective Block of the Nerve to Quadratus Femoris by Way of Percutaneous Techniques

### Bases Anatómicas para el Bloque Selectivo del nervio del músculo cuadrado femoral a Través de Técnicas Percutáneas

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**SUMMARY:** Hip joint chronic pain can severely compromise patients' life quality. Peripheral nerve blocks play an important role as diagnostic and therapeutic procedures. The aim of this work is to study the anatomy of the nerve to quadratus femoris (NQF) in view of the possibility of its percutaneous selective block. Forty-three gluteal cadaveric regions fixed in formaldehyde solution were dissected. The quadratus femoris, the obturator internus and superior and inferior gemellus were freed from their lateral insertion, exposing thus the posterior aspect of the hip joint. The NQF was identified, and the horizontal distance to the posterior edge of the greater trochanter at its upper, middle and lower thirds was registered. The number of the articular branches of the NQF was identified. Likewise, the horizontal distance to the posterior edge of the greater trochanter and the longitudinal distance to the line through the distal end of the posterior edge of the greater trochanter were measured. The distance between the NQF and the greater trochanter posterior edge at upper, middle and lower thirds was 46 mm, 41 mm and 35 mm, respectively. In most cases (85 %) the NQF presented one or two articular branches. The longitudinal distances between the line through the distal end of the posterior edge of the greater trochanter and the origin of the first, second and third articular branches of the NQF were 14.7 mm (-19.4 - 40), 16.4 mm (-9.3-42) and 27 mm (0-46), respectively. The distances to the posterior edge of the greater trochanter were 43.1 mm (16.3-66), 37.7 mm (6.5-53) and 39.8 mm (26-52), for the first, second and third articular branches, respectively. In conclusion, the articular branches of the nerve to quadratus femoris have a constant and predictable distribution. Our findings allow for generating a coordinate system for the selective block of the NQF by way of percutaneous techniques.

**KEY WORDS: Nerve to; Quadratus femoris; hip joint; selective block.**

## INTRODUCTION

Chronic hip pain is a common symptom experienced by many people. A prevalence of 7 % to 10 % is estimated in men and women over 45 years old (Okada, 1993; Birrell *et al.*, 2005; Locher *et al.*, 2008).

Osteoarthritis (OA) of the hip and knee represents the primary etiology of walking-related disability. Major symptoms of patients with hip pain include groin, thigh, and trochanteric pain (Rivera *et al.*, 2012). Quality of life is especially affected among patients with hip OA, due to limited ambulation and daily activity (Wu & Groner, 2007; Rivera *et al.*).

Conservative management of hip pain includes paracetamol, nonsteroidal anti-inflammatory drugs, narcotics, and physical modalities (Wu & Groner). Patients who fail to respond to conservative treatment usually undergo surgery. Often, surgery is not an option for patients with multiple comorbidities and conventional drugs either have many side effects or are ineffective (Rivera *et al.*). In those situations, several methods of neurolysis are available: surgical, chemical, and radiofrequency thermocoagulation (Locher *et al.*; Rivera *et al.*; Vanaclocha *et al.*, 2016).

Selective nerve block or transforaminal epidural injection consists of injection of contrast, local analgesics, or other substances around spinal nerves under fluoroscopy (Wu & Groner). In 1971 demonstrated the value of diagnostic, selective nerve blocks in the preoperative evaluation of

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patients with negative or inconclusive imaging studies and clinical findings of nerve root irritation. Since then, nerve blocks have been used to diagnose the source of radicular pain when imaging studies suggested possible compression of several nerve roots (Hoppenstein, 1980; Dooley *et al.*, 1988; Herron, 1989). Several investigators have shown the usefulness of the obturator nerve (ON) block and the femoral nerve (FN) block as a diagnostic and therapeutic tool for patients with hip joint pain but long-term benefits were not observed. The nerve responsible for hip joint pain also can be determined by diagnostic nerve block (Heywang-Köbrunner *et al.*, 2001).

Several authors proposed percutaneous radiofrequency techniques (PRT) as an alternative to selective nerve blocking of the articular branches of the ON and FN. Initial results using PRT of articular branches of the obturator and femoral nerves for treatment of hip joint pain are encouraging (Okada; Geurts *et al.*, 2001; Racz & Ruiz-Lopez, 2006; Wu & Groner).

Percutaneous denervation of the hip joint was introduced in 1981 and has been applied in patients affected by chronic articular pain. Radiofrequency is a neurolytic technique that uses heat to produce controlled tissue destruction (thermocoagulation). The tip of the electrode is usually placed near the target nerve (Rivera *et al.*).

Percutaneous pulsed radiofrequency (PRF) or conventional radiofrequency (CRF) of the articular branches of the obturator and femoral nerves is a well-known alternative treatment for hip pain that has been widely reported in literature (Dee, 1969; Wu & Groner; Locher *et al.*; Rivera *et al.*; Yavuz *et al.*, 2013; Vanaclocha *et al.*).

Based on this, different sensory branches could be treated with this variety of percutaneous techniques based upon the location of the hip pain.

Direct articular branches of adjacent peripheral nerve trunk represent the most important innervation of the hip joint. Also, small accessory articular twigs arising from the nerves within the substance of muscle surrounding the joint form a secondary innervation source (Kawaguchi *et al.*, 2001).

It is known that hip joint pain may be relieved by blocking articular branches of the ON, thigh and trochanteric pain can be relieved by blocking articular branches of the FN, and gluteal pain can be relieved by blocking articular branches of nerves innervating the posterior hip joint: superior and inferior gluteal nerves and sciatic nerve (Gupta *et al.*, 2014).

As we can see, sensory supply of the hip joint is provided by articular branches coming from several nerves. Some authors acknowledged that lack of consistently satisfactory results may have been due to anatomical variations in the sensory nerve supply to the hip (Helmick *et al.*, 2008).

The innervation of the hip joint is complex (Cruveilhier, 1844; Sadovsky, 1933; Gardner, 1948; Birnbaum *et al.*, 1997; Vanaclocha *et al.*).

The anteromedial sector of the capsule is innervated by branches of the ON (Cruveilhier; Gardner; Dee; Birnbaum *et al.*). The anterolateral sector of the hip joint capsule is innervated by articular branches of the FN (Sadovsky). Other branches often arise from the nerves to muscle overlying the hip joint (Gardner; Dee). The superolateral sector is innervated by the superior gluteal nerve. (Birnbaum *et al.*) The lower sector is innervated by the ON and the inferior gluteal nerve (Birnbaum *et al.*; Rouvière & Delmas *et al.*, 2005; Bhatia *et al.*, 2018).

The posteromedial part, posterosuperior and posteroinferior regions of the hip joint capsule are innervated by articular branches of the NQF and often by the sciatic nerve (Cruveilhier; Sadovsky; Gardner; Dee; Birnbaum). This NQF is born from the sacral plexus and emerges from the pelvis through the lower part of the greater sciatic notch. It descends before to the sciatic nerve and to the obturator internus and gemellus muscles that cover it. It provides a nerve fillet to the inferior gemellus muscle and another to the posterior hip joint capsule, and ends at the anterior side of the quadratus femoris muscle (Aung *et al.*, 2001; Rouvière & Delmas; Bhatia *et al.*).

Refractive hip pain after selective nerve block and percutaneous radiofrequency techniques over the main nerves trunks of the hip joint can be explained by the accessory innervation of other branches often arise from the nerves to muscles overlying the hip joint (Kawaguchi *et al.*; Bhatia *et al.*). The NQF is a clear example of that. Nowadays, the impact of the selective block and other percutaneous techniques of the NQF remain less clear.

As we can see, this nerve has an important role in the innervation of the posterior face of the hip joint, hence the importance of its location for eventual percutaneous procedures in the treatment of posterior gluteal pain (Vanaclocha *et al.*).

Precise knowledge of the nerve supply of the hip joint is essential to achieve a more effective and long-lasting pain reduction.

In view of the above, the aim of this work is to perform an anatomical study of the NQF in view of its percutaneous selective block and eventually other percutaneous procedures.

## MATERIAL AND METHOD

Twenty-two formalin-fixed adult cadavers were used. A total of 43 gluteal regions were dissected. All of the dissections were carried out in the laboratories of the Departamento de Anatomía, Facultad de Medicina, Universidad de la República (Montevideo - Uruguay), exclusively by the authors. Previous scars caused by surgery were not observed in the dissected areas of any specimen.

They were processed under the rules of injection and cadaver conservation of the Departamento de Anatomía, Facultad de Medicina, Universidad de la República (Montevideo - Uruguay). The use of cadaveric material was made previous donation, by written and signed informed consent.

An extended incision over the skin and subcutaneous tissues from the iliac crest to the sacral crest, at the level of the lower limb of the intergluteal groove was made. Then completed with a second horizontal incision drawn from the distal end of the anterior to the midpoint of the gluteal fold.

We separated the gluteus maximus and medius muscles from their medial insertions at the sacrum and iliac bone and then pulled back laterally to expose the deep muscular layer.

The quadratus femoris, the obturator internus and superior and inferior gemellus were freed from their lateral insertion at the femur, exposing thus the posterior aspect of the hip joint. The NQF was identified, and a careful dissection of its articular branches was made.

Using calipers, several measurements were made (Fig. 1):

- The NQF was identified, and the horizontal distance to the posterior edge of the greater trochanter at its upper, middle and lower thirds was registered.
-The number of the articular branches of the NQF was identified.
-About each articular branch, the horizontal distance between its origin of the nerve's trunk, and the posterior edge of the greater trochanter was registered. Also the longitudinal distance between its origin and the horizontal line through the distal end of the posterior edge of the greater trochanter (HLGT).
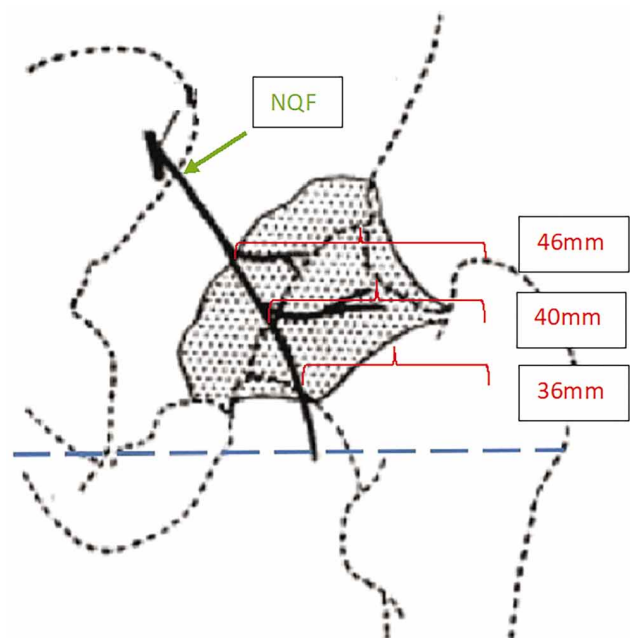


Fig. 1. this figure shows average distances between the NQF and the greater trochanter posterior edge at upper, middle and lower thirds was 46mm, 41mm and 35mm, respectively.

## RESULTS

The presence of NQF articular branches to posterior hip joint capsule were found in all of the cases (100 %). The NQF presented a downward and lateral oblique descending path along the posterior aspect of the hip joint capsule (Fig. 2).

The average distance between the NQF and the greater trochanter posterior edge at upper, middle and lower thirds was 46 mm, 41 mm and 35 mm, respectively (Fig. 1).

Of the 43 gluteal regions, 87 articular branches to the hip joint were found, each with 1 to 3 articular branches being found. In 39.5 % of cases a single articular branch was found. In 46.5 % of cases they originated 2 articular branches, and only in 14 % of cases originated 3 articular branches. In most cases (85 %) the NQF presented one or two articular branches. An average of 1.6 joint branches was recorded.

The distances between HLGT and the origin of the first, second and third articular branches of the NQF were 14.7 mm (-19.4 - 40), 16.4 mm (-9.3-42) and 27 mm (0-46), respectively.

The distances to the posterior edge of the greater trochanter (PEGT) were 43.1 mm (16.3-66), 37.7 mm (6.5-
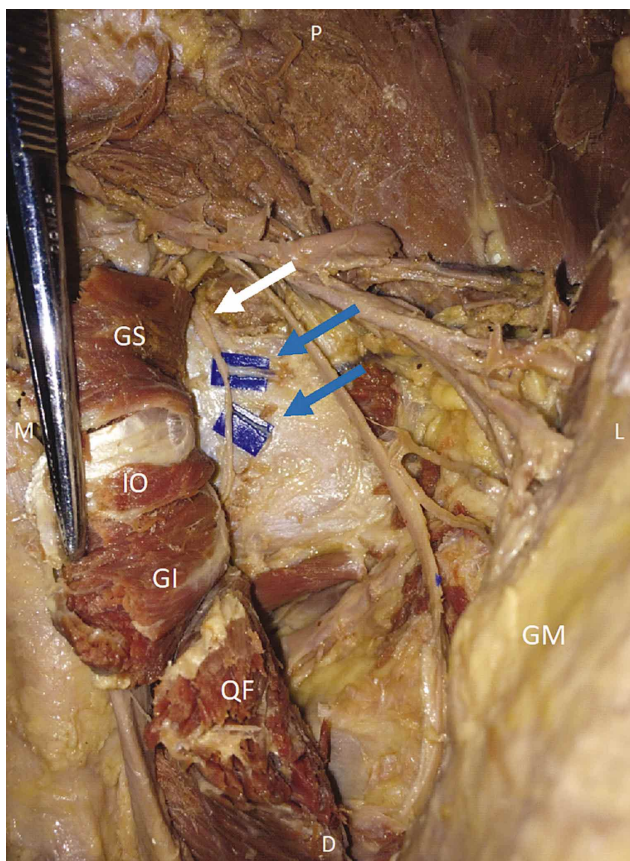
53) and 39.8 mm (26-52), for the first, second and third articular branches, respectively.

On average, each branch is found in the following coordinates. The first (upper) articular branch is 43.1 mm from the PEGT and 14.7 mm from the HLGT (Fig. 3). The second branch is 37.7 mm from the PEGT and 16.4 mm from the HLGT (Fig. 4). Finally, the third branch is 39.8 mm from the PEGT and 27 mm from the HLGT (Fig. 5).



Fig. 2. posterior view of a right gluteal region. The gluteus maximus (GM) was fought medially and the gemellus superior (GS), obturator internus (OI), gemellus inferior (GI) and the quadratus femoris muscles were fought back laterally. We appreciate the posterior face of the hip joint and the nerve to quadratus femoris (NQF-white arrow) leaning down with 2 articular branches (blue arrows).



Fig. 4. Graphic of the topography of the second articular branch, in relation to the posterior edge of the greater trochanter and the line through the distal end of the posterior edge of the greater trochanter. Includes coordinates of 20 branches. They are on average at a horizontal distance of 37.8 mm and at a longitudinal distance of 16.4 mm.
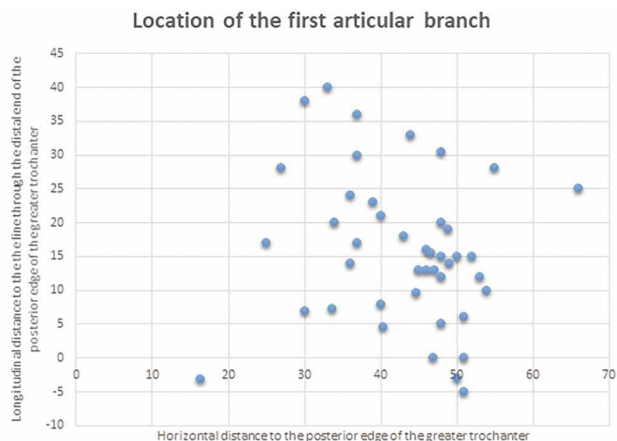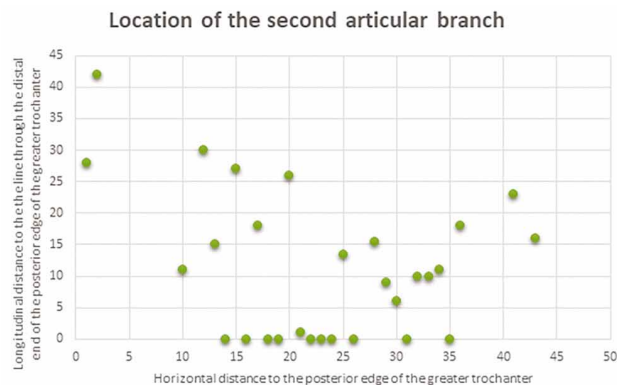


Fig. 3. Graphic of the topography of the first articular branch, in relation to the posterior edge of the major trochanter and the line through the distal end of the posterior edge of the greater trochanter. Includes coordinates of 43 branches. They are on average at a horizontal distance of 43.1 mm and a longitudinal distance of 14.7 mm.
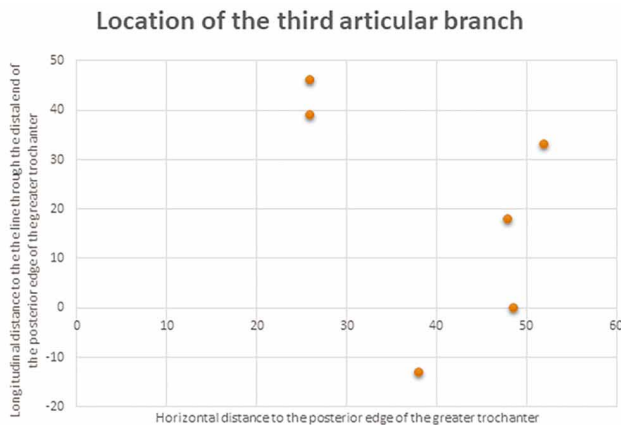


Fig. 5. Graphic of the topography of the third articular branch in relation to the posterior edge of the greater trochanter and the line through the distal end of the posterior edge of the greater trochanter. Includes coordinates of 6 branches. They are on average at a horizontal distance of 39.8 mm and a longitudinal distance of 27 mm.

## DISCUSION AND CONCLUSION

Nerve to quadratus femoris (NQF).The NQF was identified at all levels of the posterior edge of the greater trochanter at an average distance of 40 mm. This means that the NQF can be found in the nearest 40 mm of the PEGT. Being the closest sector to it at the lower third, presenting an average distance of 35 mm.

We found the NQF in all the cases (100 %), giving articular branches to the posterior regions of the hip joint capsule. This is consistent with the literature consulted (Cruveilhier; Sadovsky; Gardner; Dee; Birnbaum *et al.*; Rouvière & Delmas; Aung *et al.*). According with contemporary authors, the posterior articular nerves consist of a varying number of short (5-6 mm long) articular branches of the nerve to the quadratus femoris muscle, and represent the most prolific supply to the hip joint (Dee).

Articular branches: In our study we found between one to three articular branches. An average of 1.6 joint branches was recorded. These results were similar to the consulted bibliography. Birkman *et al.*, found between 1 and 5 branches, Bathia *et al.*, found an average of 3 and Gardner found 1 or 2 in most of the cases.
According to Dee, the superior and middle branches curve upward along the acetabular rim to supply the posterior joint capsule, whereas the inferior branches run directly along the upper margin of the obturator externus where they are distributed to the posteroinferior region of the joint capsule (Dee).

**Limitations:** Percutaneous procedures have their limitations. The innervation of the hip joint is varied and is supplied by numerous nerve branches. Some authors explain that radiofrequency denervation and other percutaneous techniques of all these nerves are unfeasible (Sadovsky; Locher *et al.*).

On the other hand, some authors explain that the lack of pain relief in some cases despite a correctly performed procedure, may be explained by the fact that innervation of the hip varies from patient to patient (Okada; Vanaclocha *et al.*). In our study we found a small variability between one gluteal region and another.

In conclusion, the articular branches of NQF have a constant and predictable distribution. Our findings allow to generate a coordinate system to survey the NQF path, identifying where its articular branches originate. This is essential to achieve a more effective technique.

Future research on patients undergoing selective nerve blockade of this nerve and other percutaneous techniques could study the long-term usefulness.

Further research based on anatomical topographic mapping of the nerve to quadratus femoris and its articular branches obtained in our work lend themselves to correlation with future clinical trials to try out its diagnostic and therapeutic viability.

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**RESUMEN:** El dolor crónico de la articulación coxal puede comprometer severamente la calidad de vida de los pacientes. Los bloqueos nerviosos periféricos juegan un papel importante como procedimientos diagnósticos y terapéuticos. El objetivo de este trabajo es estudiar la anatomía del nervio del músculo cuadrado femoral (NCF) en vista de la posibilidad de su bloqueo selectivo percutáneo. Se utilizaron 22 cadáveres fijados en solución de formaldehído. Fueron disecadas en total 43 regiones glúteas. Los músculos cuadrado femoral, obturador interno y los gemelos superior e inferior fueron liberados de su inserción lateral, exponiendo así la cara posterior de la articulación coxal. Se identificó el NCF y se registró la distancia horizontal al margen posterior del trocánter mayor en sus tercios superior, medio e inferior. Se identificó el número de ramas articulares del NCF. Asimismo, se midió la distancia horizontal al margen posterior del trocánter mayor y la distancia longitudinal a la línea que pasa por el extremo distal del margen posterior del trocánter mayor. La distancia entre el NCF y el margen posterior del trocánter mayor en los tercios superior, medio e inferior fue de 46 mm, 41 mm y 35 mm, respectivamente. En la mayoría de los casos (85 %) el NCF presentó una o dos ramas articulares. Las distancias longitudinales entre la línea que pasa por el extremo distal del margen posterior del trocánter mayor y el origen de la primera, segunda y tercera ramas articulares del NQF fueron 14,7 mm (-19,4 - 40), 16,4 mm (-9,3-42) y 27 mm (0-46), respectivamente. Las distancias al margen posterior del trocánter mayor fueron 43,1 mm (16,3-66), 37,7 mm (6,5-53) y 39,8 mm (26-52), para la primera, segunda y tercera ramas articulares, respectivamente. En conclusión, las ramas articulares del nervio al cuadrado femoral tienen una distribución constante y predecible. Nuestros hallazgos permiten generar un sistema de coordenadas para el bloqueo selectivo del NCF por medio de técnicas percutáneas.

**PALABRAS CLAVE: Nervio; Cuadrado femoral; Articulación coxal; Bloqueo selectivo.**

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