Retrospective Evaluation

Ultrasound-Guided Quadratus Femoris Muscle Injection in Patients with Lower Buttock Pain: Novel Ultrasound-Guided Approach and Clinical Effectiveness

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Background: The quadratus femoris (QF) muscle is a possible source of lower buttock pain as evidenced by what is known about the pathophysiology of ischiofemoral impingement syndrome. However, there are few reports about the interventional management of the QF muscle as a pain generator.

Objective: To describe an ultrasound-guided QF muscle injection technique in patients with lower buttock pain suspected of QF muscle pathology and to report the result of treatment.

Study Design: Retrospective evaluation.

Setting: Outpatient department for interventional pain management at a university hospital.

Methods: We studied 14 patients who had deep tenderness localized to the lower buttock region at a point halfway between the lateral prominence of the greater trochanter and the ischial tuberosity corresponding to the location of the QF muscle belly. Under ultrasound guidance, 8 mL of 0.25% lidocaine was injected into the QF muscle. Pain scores were assessed prior to the first injection and 2 weeks after the last injection. Patient satisfaction was also assessed.

Results: When compared before and 2 weeks after last QF muscle injection, the mean pain score decreased by 49.3% (6.7 ± 2.3 to 3.4 ± 2.1, $P < 0.001$). Two weeks after the last injection, approximately 70% of patients (10 of 14 patients) expressed their satisfaction as excellent or good and the average frequency of injection was 2.5 times. There were no complications observed.

Limitations: The results of this study should be considered preliminary owing to the small sample size and lack of a control group, and the retrospective characteristics of this study may have introduced a selection bias.

Conclusions: Ultrasound-guided QF muscle injection with local anesthetic helps alleviate pain in patients with lower buttock pain attributed to the QF muscle, and leads to high levels of satisfaction for patients. A randomized placebo-controlled trial should be considered in the future.

Key words: Buttocks, injections, intramuscular, myofascial pain syndromes, quadratus femoris, ultrasonography

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The etiology of buttock pain is diverse; it can be caused by local damage, can originate in the pelvis or the hip, or may be related to the lumbosacral spine or surrounding neurovascular structures (1). Furthermore, the complex anatomy of the buttock and pelvis, variability of presentation, and non-specific nature of the presenting signs and symptoms make the diagnostic process of buttock pain more complicated (2).

Among disorders which cause buttock pain, ischiofemoral impingement syndrome can develop due to narrowing of the ischiofemoral space and is characterized by buttock pain with hip flexion and posterior thigh pain due to irritation of the sciatic nerves (3). It has been reported that edema, partial tears, and fluid collections in the quadratus femoris (QF) muscle can be observed on pelvic magnetic resonance imaging (MRI) in patients with ischiofemoral impingement syndrome (3). Total hip arthroplasty, proximal femoral osteotomy, and abduction injury to the hip have been reported to be causes of ischiofemoral impingement (4), but a recent case report has also described an instance in which this was diagnosed in the absence of any inciting surgery or trauma (5).

Dalmau-Carolà (6) reported that fluoroscopically guided intramuscular injections in select cases for diagnostic purposes helped alleviate pain in patients who had a trigger point in the QF muscle. For a piriformis muscle injection, an ultrasound-guided injection is known to be more accurate than a fluoroscopically guided injection in a cadaveric model (7), and the 2 techniques are reported to have no difference in clinical outcomes (8). Thus, it is expected that QF muscle injection under ultrasound guidance will be an accurate and safe procedure (9). Although there was a case report which described giving patients with QF tendinitis an injection to the QF tendon under ultrasound guidance, no detailed technique was described (10).

The aims of this retrospective observational study were to describe an ultrasound-guided QF injection technique in patients with lower buttock pain suspected of QF muscle pathology and to report the result of treatment.

Methods

This retrospective study was approved by our hospital's institutional review board (Ref. 4-2014-0211), and the requirement for written consent was waived. The clinical records were reviewed for patients who underwent ultrasound-guided QF muscle injections with local anesthetic for pain treatment in an outpatient department for pain management between March 2013 and March 2014. Patients with lower buttock pain who localized their tenderness to the lower buttock region at a point halfway between the lateral prominence of the greater trochanter and the ischial tuberosity corresponding to the location of the QF muscle belly were identified as participants for QF muscle injection. Additionally, patients must have had no pain in the anterior side of the hip. If lumbar facet syndrome, radicular pain caused by lumbar disc herniation, lumbar spinal stenosis, or buttock pain originating from other structures (ex. sacroiliac joint pain) was identified on imaging or physical examination, treatment for those conditions was prioritized. QF muscle injection was given for lower buttock pain that persisted despite appropriate interventions for alternative diagnoses. Patients were excluded if they were pregnant, or had a coagulopathy, systemic infection, or a contrast media allergy.

Location of the QF Muscle

Patients were placed in the prone position on the bed, and sterile preparation and draping was applied. All injections were performed by a single expert pain physician (K.B.Y.) at intervals of 2 weeks. Deep and localized tenderness of the lower buttock region cor-

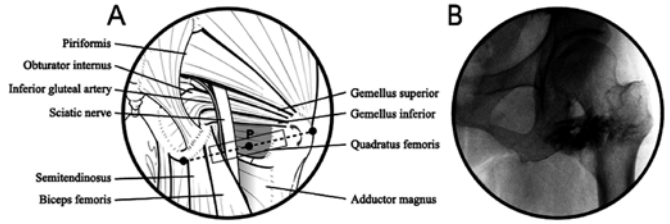

Fig. 1. *(A) Anatomical location of the quadratus femoris (QF) muscle. Point P is halfway between the lateral prominence of the greater trochanter and the ischial tuberosity and is identified as the point of focal tenderness reproducing the typical pain of the patients. Curved double arrow indicates the rotation of the ultrasound transducer. (B) Anteroposterior fluoroscopic image of the right hip showing the contrast media has been injected into the QF muscle and has diffused fully.*

responding to the QF muscle was investigated and we repeated QF muscle injections in case of the existence of tenderness. In the case of the first patient, the point of focal tenderness which reproduced typical buttock pain was identified as being located halfway between the lateral prominence of the greater trochanter and the ischial tuberosity based on surface anatomy. Fluoroscopic examination confirmed that this point was where the QF muscle was located (Fig. 1A and 1B).

Injection Technique

Ultrasound-guided injection was performed on all other patients without fluoroscopic examination using a technique for QF muscle injection modified from Karmakar et al's (11) technique for the subgluteal space injection under ultrasound guidance at QF muscle level in order to perform a sciatic nerve block. The examiner palpated the lateral prominence of the greater trochanter and the ischial tuberosity, then drew a line between the 2 surface bony landmarks. The examiner then applied ultrasound gel to the skin and positioned a 2 – 5 MHz curvilinear probe (SonoSite S-Nerve Ultrasound System, Sonosite, Inc., Bothell, WA, USA) parallel to the line drawn earlier at an angle of 90 degrees to the bed, rather than the skin. The probe was moved inch by inch cephalad or caudad, and slightly rotated if necessary to optimize the ultrasound image for the injection (Fig. 2A and 2B). At the level where the ultrasound probe was located, the greater trochanter and the ischial tuberosity were easily observed at their lateral and medial borders, respectively, when the patient was positioned laterally with the hip and knees flexed (11). However, the ultrasound scan in the present study was performed in the prone position, so the intertrochanteric crest and the ischium were the bony landmarks observed at their lateral and medial borders, respectively (Fig. 2B). At this level, the honeycomb-shaped hyper-echogenic sciatic nerve of the hypo-echogenic subgluteal space was observed between the thick gluteus maximus muscle and the thin QF muscle, and a pulsatile inferior gluteal artery or its branch was examined using a color Doppler scan (Fig. 3A). Then, under ultrasonographic guidance, a 22-gauge, 100-mm block needle was used to enter the skin 5 mm from the side of the probe to circumvent the sciatic nerve and inferior gluteal artery or its branch. The needle tip was advanced inside the QF muscle in a transverse long-axis view, then 8 mL of 0.25% lidocaine was injected under ultrasonography to confirm that the injectate did not leak into the subgluteal space or gluteus maximus, and that it diffused throughout the fascial border containing the QF muscle belly (Fig. 3B and 3C).

Assessment

Demographic and clinical data including gender, age, duration of pain, location of pain, and previous pain intervention history were collected for analysis. Any history of pain with sitting, walking problems, a snapping sensation at the hip, and hip joint range of motion was detailed. An 11-point numerical rating scale (NRS, 0 = no pain, 10 = worst pain) pain score before any QF muscle injection and 2 weeks after the

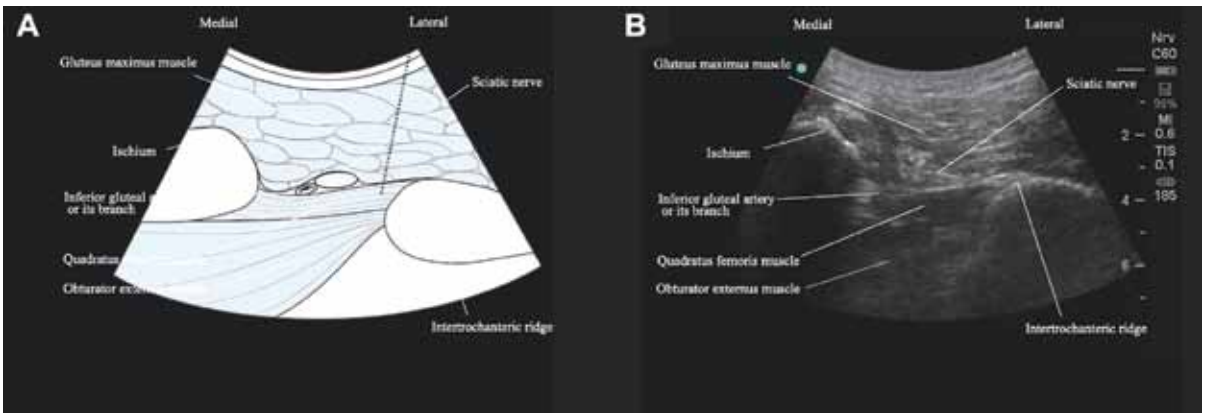

Fig. 2. *(A) Schematic transverse section of the region between the ischium and the intertrochanteric ridge for ultrasound-guided quadratus femoris (QF) muscle injection. The dotted line indicates the expected needle path. (B) Sonogram of the region between the ischium and the intertrochanteric ridge showing the sciatic nerve and the QF muscle.*

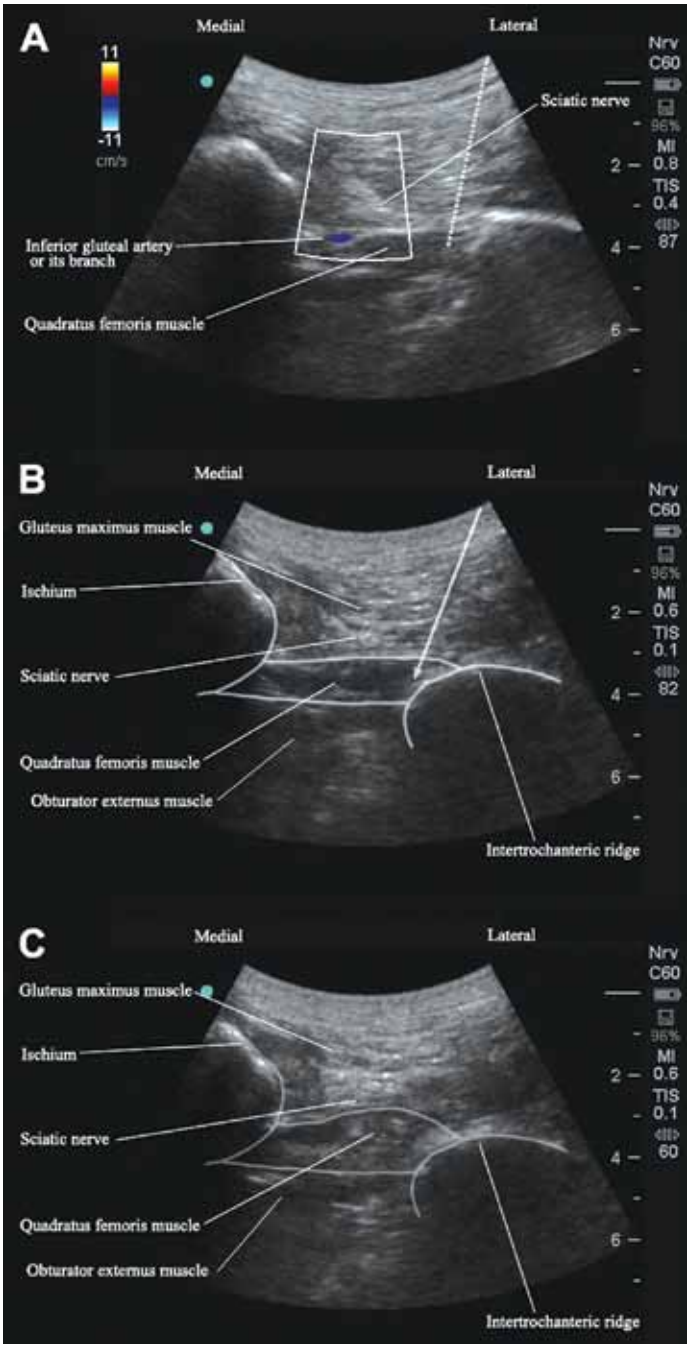

Fig. 3. *Ultrasound-guided quadratus femoris (QF) muscle injection. (A) Sonogram of the region between the ischium and the intertrochanteric ridge with a color Doppler scan showing the inferior gluteal artery or its branch. The dotted line indicates the expected needle path. (B) Sonogram showing the spread of local anesthetic within the QF muscle after positioning the needle and starting the injection. Arrow indicates the needle shaft and the needle tip. (C) Sonogram of the QF muscle showing the QF muscle bulging slightly after injection.*

last injection were obtained. The degree of patient satisfaction was also assessed using a scale of excellent, good, fair, or poor 2 weeks after the last injection. Complications associated with QF muscle injection such as hematoma formation, nerve injury, or infection were investigated, as were any motor or sensory changes in the territory innervated by the sciatic nerve by checking any weakness of knee flexion, ankle dorsiflexion, and ankle plantar flexion, or any numbness in the lateral thigh, posterior thigh, and lower leg and foot 30 minutes after QF muscle injection and 2 weeks later at the next hospital visit.

Statistical Analysis

Continuous data are presented as the mean ± standard deviation or median (range). Categorical data are reported as both a frequency and percentage. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test. A paired t-test was used for comparing mean pain scores before and 2 weeks after the last QF muscle injection. Other comparisons were done with the independent t-test, Mann-Whitney U-test, chi-squared test, and Fisher's exact test, as appropriate. Statistical analysis was conducted using the Statistical Package for the Social Sciences 18.0 for Windows (SPSS Inc., Chicago, IL, USA). A P-value < 0.05 was considered statistically significant.

Results

Data from 14 consecutive patients who underwent ultrasound-guided QF muscle injections were analyzed. Patient characteristics and clinical presentations are shown in Table 1. Two patients had a history of trauma to the lower buttock, 3 had a history of laminectomy, 2 had histories of both laminectomy and discectomy, and one had a history of posterior lumbar spinal fusion after laminectomy. Approximately 70% of patients (10 of 14 patients) complained of more severe pain in the sitting position, of which 3 complained of more acute pain while driving, and 2 described pain worsened by cycling. Approximately 20% of

patients had problems with walking, such as limping, and no patients had a snapping sensation at the hip. On physical examination, the range of motion for both hips was full and symmetric in all patients. Three patients had a hip MRI which showed normal findings.

When compared before and 2 weeks after the last QF muscle injection, the mean pain score decreased by 49.3% (6.7 ± 2.3 to 3.4 ± 2.1, $P < 0.001$). At 2 weeks after the last injection, approximately 70% of patients (10 of 14 patients) expressed their satisfaction as excellent or good and their average frequency of injection was 2.5 times (Table 2). When we classified the patients into the excellent and good group or the fair and poor group according to the degree of patient satisfaction, the changes of NRS score were significantly different ($P = 0.024$), whereas the duration of pain and the number of QF muscle injection were not (Table 3). No temporary sciatic palsy occurred after injection, and no patient sustained deleterious effects from the injections, which were otherwise performed without complications.

Discussion

In the present study, the authors found that ultrasound-guided QF muscle injection with local anesthetic provided a high level of satisfaction as well as relief of pain attributed to the QF muscle in patients with lower buttock pain and posterior thigh pain. The response signified that in patients with deep localized tenderness of the lower buttock region corresponding to the QF muscle, selective QF muscle injection conferred diagnostic and therapeutic benefits if the possibility of other pain generators were clinically excluded. Through fluoroscopic examination, the above-mentioned focal and deep tenderness was found to correspond to the location of the QF muscle, but the specific cause of the tenderness was not clear.

The QF muscle is a short, flat, and quadrilateral-shaped muscle, which originates from the inferolateral margin of the ischium along the anterior portion of the ischial tuberosity just anterior to the origin of the hamstring tendons, and is inserted at the intertrochanteric ridge of the posterior medial aspect of the proximal femur (Fig. 1A) (12). The QF muscle borders the obturator externus muscle anteriorly and adjoins the fat and the sciatic nerve posteriorly (12). The QF nerves innervate the QF muscle from the anterior surface through the anterior surface of the gemelli muscles (13). The QF muscle acts as an external rotator of the hip and

Table 1. *Patient characteristics and clinical presentations.*

Gender (M/F)	8/6
Age, years	53.4 ± 12.9 (33 to 72)
Side (right/left/both)	6/4/4
Duration of pain, months	4 (1 month to 15 years)
Pain sites, n (%)	
Lower back and lower buttock	1 (7)
Lower buttock only	4 (29)
Lower buttock and posterior thigh	9 (64)
Sitting pain, n (%)	10 (71)
Walking problems, n (%)	3 (21)
Snapping hip, n (%)	0 (0)
Previous pain intervention, n (%)	
Piriformis injection	9 (64)
Myofascial trigger points injection	6 (43)
Sacroiliac joint injection	5 (36)
Lumbar transforaminal epidural injection	4 (29)
Ischial tuberosity bursa injection	4 (29)
Psoas compartment block	3 (21)
Other procedures	8 (57)

Values are presented as the mean ± standard deviation (range), median (range) or number of patients (%).

Table 2. *Pain scores before and 2 weeks after the last quadratus femoris muscle injection and the degree of patient satisfaction 2 weeks after the last injection.*

NRS pain score before injection	6.7 ± 2.3 (3 to 10)
NRS pain score after injection	3.4 ± 2.1 (0 to 8)*
Patient satisfaction, *n* (%)	
Excellent	4 (29)
Good	6 (43)
Fair	3 (21)
Poor	1 (7)
Number of QF muscle injection, *n* (%)	
1	5 (36)
2	7 (50)
3	1 (7)
≥ 4	1 (7)

Values are mean ± standard deviation (range) or number of patients (%).
*$P < 0.001$.
NRS, numeric rating scale; QF, quadratus femoris.

Table 3. *Comparison of clinical variables between the excellent and good group vs. the fair and poor group.*

	The excellent and good group (n = 10)	The fair and poor group (n = 4)	*P* value
Change of NRS pain score	3.7 ± 0.9	2.6 ± 0.9	0.024*
Duration of pain, months	3 (1 month to 15 years)	15 (3 to 84)	0.240
Number of injection, n	2 (1 to 14)	2 (1 to 2)	1.000

Values are presented as the mean ± standard deviation or median (range).
* $P < 0.05$.
NRS, numeric rating scale.

helps with adduction (14). Considering its anatomic location, the relationship to surrounding tissues, and its functions, the QF muscle is a potential candidate for a source of pain and irritation, and the findings of this study support this theory.

One of the possible causes of localized tenderness in the QF muscle is an ischiofemoral impingement syndrome. Principally, the edema associated with impingement of the muscle is typically centered in the muscle belly at the side of maximal impingement (3). Thus, focal tenderness of the QF muscle identified by applying deep pressure at a point halfway between the ischial tuberosity and the lateral prominence of the greater trochanter may be caused by ischiofemoral impingement syndrome. However, narrowing of either the ischiofemoral space or the quadratus femoris space was not found in 3 patients who had a hip MRI, and ischiofemoral impingement syndrome was not clearly identified in the rest of patients as they did not have a hip MRI or pelvic MRI.

Another possible cause of localized tenderness in the QF muscle is myofascial pain syndrome (MPS). Piriformis syndrome is known to cause trigger points to form (15), and in a study by Dalmau-Carolà (16), trigger point injections of the obturator internus muscle helped alleviate the buttock pain experienced by patients with this syndrome. Thus, trigger points can also occur in the QF muscle as the external rotator of hip like with the piriformis muscle or obturator internus muscle subsequent to recurring microtrauma that can occur with overuse, bad posture, or an affected gait. However, unlike the piriformis or obturator internus muscle, the nerve to the QF muscle originates from the fourth and fifth lumbar nerve formed by the cranial-most roots of the sacral plexus (13). If one has a primary pathology at the lumbar level, it is possible that trigger points can occur in the QF muscle by a segmental relationship based on the anatomic convergence of sensory information in the spinal cord (17).

Inflammation and spasm of the QF muscle that affects the sciatic nerves is another possible cause of pain in the area of the QF. Considering the close anatomical relationship of the sciatic nerve to the anterior surface of the gluteus maximus and the posterior surface of the QF muscle, any inflammation, spasm, tightening, and swelling of the QF muscle can irritate the sciatic nerves (15,16,18,19). In this case, local anesthetic with glucocorticoids as an injectate may be more effective, and if so, botox injection can be also considered. These spasms and tightening of the QF muscle could be the cause of the sitting pain that approximately 70% of patients reported.

Almost 50% of patients with greater trochanteric pain syndrome complain of radiation to the buttock or down the lateral aspect of the thigh to the knee (20). It is known that the main pathologic condition of greater trochanteric pain syndrome is the tendinosis of muscles inserted in the greater trochanteric region and intertrochanteric region rather than the greater trochanteric bursitis (21,22). We could observe local anesthetic spread through the muscle and/or tendon to the intertrochanteric crest during QF muscle injection and the considerably positive response with local anesthetic alone without combination of corticosteroids. Therefore, although this injection was aimed at the patients with localized tenderness in the QF muscle, some patients possibly were responding to the treatment of greater trochanteric pain syndrome combined with QF muscle pathology as a result.

Studies involving the QF muscle are lacking; pathologies and the underlying mechanisms involving the QF muscle are yet to be understood fully and there have been few therapeutic advances in QF muscle diseases (6,23,24). In a recent study, Backer et al (24) examined the effectiveness of ultrasound-guided corticosteroid injection of QF in patients with MRI findings of ischiofemoral impingement. Also, as the ischial tuberosity and the lesser trochanter were set as bony landmarks, there is a possibility that a significant number of the injections were performed into the lower border of caudal direction of the QF muscle. Even though the procedures were performed under ultrasound guid-

ance, the authors contemplate even the possibility of perimuscular injection straying from the QF muscle. In a previous study, the injection technique which Kim et al (23) introduced also seemed to have the same limitations in terms of selective QF injection. In this study, on the other hand, the authors used the ischium and the intertrochanteric crest as the bony landmarks. Under real-time ultrasonography, we performed injections ensuring that the injection did not leak into the subgluteal space or gluteus maximus, confirming the position of the injection by checking the QF muscle bulging slightly after the injection. Therefore, the injection technique introduced in the present study was the most appropriate and accurate method for selective QF muscle and/or tendon injection.

Regarding the use of trigger point injections to treat MPS, it is reported that the appropriate concentration of lidocaine is 0.25% and an ample volume is 1 – 3 mL (25). When the cause of localized tenderness in the QF muscle could not conclusively be attributed to MPS, nerve irritation caused by spasm, tightening, and swelling was also considered on the differential. Injection of local anesthetic into the piriformis muscle reduces the swelling or spasm of the muscle for piriformis syndrome as well, so 5 – 10 mL of a diluted local anesthetic was injected into the belly of the piriformis muscle (15). For our first patient (male, body mass index 21.2 kg/m2), 2 mL of contrast media was injected in advance. Then under both live fluoroscopy and real-time ultrasonography, 6 mL of saline-diluted 0.25% lidocaine was injected without leakage of contrast media outside of the QF muscle. An injectate volume of 8 mL appeared to be a sufficient quantity of local anesthetic to bathe the greater part of the QF muscle without leakage. Therefore, 8 mL of 0.25% lidocaine was used as the injectate for the rest of the patients under ultrasound guidance only.

This study has its limitations. First, the results of this study should be considered preliminary owing to the small sample size, and the retrospective characteristics of this study may have introduced a selection bias. However, it is uncommon for the QF muscle to be identified as the main pain generator in patients with lower buttock pain, and all patients who were treated with QF muscle injections for one year in our outpatient department in the present study were reviewed. Second, other tools were not proposed for the examination or evaluation of QF muscle pathology to localize tenderness or characterize other clinical manifestation. The utility of methods such as electromyography, computed tomography, and MRI for the diagnosis of QF pathology can be evaluated in future studies.

Conclusions

Ultrasound-guided QF muscle injection with local anesthetic helps alleviate lower buttock pain in the patients for whom the QF muscle is believed to be the primary pain generator, and the use of this technique leads to high levels of patient satisfaction. Selective QF muscle injection under ultrasound guidance in the present study may help diagnose buttock pain and can be considered in the therapeutic approach to a select group of patients with deep tenderness localized to the QF muscle.

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