Original Research

Ultrasound elastography findings in piriformis muscle syndrome

Short title/Running head: Elastography in piriformis muscle syndrome
Introduction/Purpose

Piriformis muscle syndrome (PMS) is a neuropathy caused by either the pressure or irrigation of the sciatic nerve by the piriformis muscle. It constitutes 6-8% of the back and sciatic pain cases. Since, this less known and rarely suspected syndrome could be confused with other pathologic conditions; delayed diagnosis could lead to pain, paresthesia, hyperesthesia and muscle weakness caused by somatic dysfunction and compensatory changes from pressure on the sciatic nerve. Our purpose was to evaluate the diagnostic performance of the elastographic muscle strain rates as with the help of easy and cheap diagnostic tool, ultrasound elastography, early diagnosis and less invasive methods could achieve treatment goals in cases with PMS as the initial diagnosis.

Materials and Method

28 cases who were diagnosed by routine diagnostic tools in the PTR outpatient clinic underwent ultrasound elastography. Elastographic strain rate was calculated by dividing the strain rate of the subcutaneous fat tissue to the average strain rate of the muscle. The diagnostic performance rate of the strain rates obtained by this method were compared by ROC curve analysis.

Results

21 of the cases were female while 7 were male. Median age was 45. Average strain rate was; 1.59±1.21 in the piriformis muscle; 1.01±1.05 in the gluteus maximus muscle correspondingly in the PMS side while 0.56±0.47 in the piriformis muscle; 0.42±0.35 gluteus maximus muscle in the normal side. PMS diagnosed side’s strain rates were found to be statistically significant (p<0.001). It was 0.878 (95% confidence interval 0.774-0.981) in the piriformis muscle and 0.768 (95% confidence interval 0.622-0.913) in the gluteus maximus muscle. When 0.765 was used as the limit in the piriformis muscle sensitivity and specificity values were 80.95% and 85.71% consecutively. When 0.420 was used as the limit in the gluteus maximus muscle sensitivity and specificity values were 85.71% and 66.67% consecutively. When %124.62 was used in the piriformis muscle, sensitivity and specificity rates were 100%; when 100.4% was used in the gluteus maximus muscle sensitivity rate was 100% and specificity rate was 95.24%, strain rate increase percentage when compared to the normal side.

Conclusion

By using the easy and cheap ultrasound elastography PMS could be diagnosed early and treatment could be done with less invasive methods.
Keywords: Piriformis muscle syndrome, Elasticity Imaging Techniques; Ultrasound
Piriformis muscle syndrome (PMS) is a neuropathy caused by either the pressure or irritation of the sciatic nerve by the piriformis muscle (PM) (1). It was first described by Yeoman in 1928. Robinson formed the 6 itemed diagnostic list in 1948 (2, 3). Piriformis muscle is a flat pyramidal shape muscle (4) which originates from the anterior surface of the sacrum, S2-S4 level sacroiliac joint capsule, passing through the greater sciatic foramen attaching to the superior surface of the greater trochanter of the femur (5). Its neighbor are obturator internus and gemelli muscles (5, 6). PM’s function changes with the position of the hip (4). PM is innervated by S1 and S2, and rarely L5 spinal nerve roots. PM makes external rotation to the hip when the hip is in neutral position, abduction when the hip is in flexion and it allows postural stability when standing and walking (7). PM’s neighbor, the sciatic nerve originates from the lumbosacral plexus (L4-S3). It passes through the sciatic indentation below the piriformis muscle leaving the pelvis (7, 8).

PMS may result from the variation of the relationship between the piriformis muscle and the sciatic nerve or the micro and macro trauma caused by the piriformis muscle (9). Piriformis muscle syndrome constitutes 5-6% of the back and sciatic pain cases (10). It is seen 6 times more in women than men as biomechanically the quadriceps femoris muscle has a wider angle in the female pelvis. The incidence of PMS increase in the 4th and 5th decades, its clinical diagnosis is quite hard to establish. The real case incidence is thought to be higher than the diagnosed cases as it could be confused with the other clinical pathologic situations. Thus, healthy epidemiological data cannot be obtained (5, 9, 11-16). The delayed diagnosis of this lesser known and lesser taken into consideration clinical state, could lead to pain, paresthesia, hyperesthesia and muscle weakness caused by somatic dysfunction and compensatory changes from pressure on the sciatic nerve. This situation makes the treatment harder and more invasive (17). It could be kept in mind in the differential diagnosis in female patients with hip pain (18). Diseases that could cause back and sciatic pain that could irritate the sciatic nerve like sacroiliac joint dysfunction, facet syndrome, spinal stenosis, trochanteric bursitis, myofascial pain syndrome, pelvic tumor and endometriosis must be kept in mind in the differential diagnosis of PMS (19). PMS could be diagnosed by pain in the piriformis muscle, sacroiliac joint and over the sciatic indentation. The spasm in the piriformis muscle could lead to the palpation of a sausage like mass in the buttocks. Traction of the lower extremity could alleviate the pain (8) Tensor fascia lata, gluteus minimus, gluteus maximus, adductor magnus, quadratus femoris and obturator externus muscles could also be affected by PMS (17).

The trapping of the sciatic nerve by the PM lead to hip and leg pain, pain in the posterior thigh and rarely dysthesia radiating to the leg and foot (20). Six items used by Robinson in diagnosis are: history
of local trauma; pain in the hip and sciatic nerve distribution area, difficulty in walking; pain in lifting
the lower extremities which is relieved by stretching the hip muscles; sensitivity in deep palpation of
the PM and palpation of the muscle like sausage; positivity in the Laseque test and gluteal atrophy in
some advanced cases (2).

Although there isn’t a single definite diagnostic test, radiography, MRI and electrophysiological
evaluation can be used in differential diagnosis. ‘Ultrasound elastography’ (UE) which came into use
in the recent years could help overcome the hardship in the diagnosis. Ultrasound elastography is an
ultrasound based technique which defines the mechanical properties of the tissue by quantitative,
visual and qualitative measurements instead of B-mod (acoustic impedance) or color Doppler
(vascular blood flow). In this technique the density of the tissue is defined thus diagnosis could be
reached by comparing the elasticity of the piriformis muscle. There are several techniques for
measurement “strain elastography’ being the most used one. With the application of outside
pressure soft tissues show more and firm tissues show less deformation. This information is coded
colorfully in the monitor and quantitative data are obtained in the measurements from fields of
interest (ROI) (21-23).

Utilization of an easy and cheap method like ultrasound elastography in patients with the initial
diagnosis of PMS, could lead to early diagnosis and treatment with less invasive methods. In this
study UE method was used to evaluate the findings in cases with the clinical PMS diagnosis.

MATERIALS and METHOD

Cases

Patients who admitted to the PTR outpatient clinic with hip pain that is aggravated by sitting or
kneeling or standing up; numbness and weakness in the leg; who underwent work up for lumbar,
vertebral and hip pathologies and left undiagnosed; underwent detailed physical examination with
the initial diagnosis of PS. Sensitivity on the sacroiliac joint, greater sciatic indentation, area around
the piriformis muscle and the piriformis muscle on the painful side; palpable mass in the hip on the
ipsilateral side; mild relief with the traction of the affected hip; asymmetrical weakness in the
affected hip; Piriformis finding (+), Laseque test (+), Freiberg finding (+), Pace finding (+), Beatty
test(+) and limitations in internal rotation on the lower extremity were needed for the clinical
diagnosis of PMS. Patients that could have other pathologic conditions other than PMS that could
affect the sciatic nerve were excluded from the study. Lumbar or hip MRI of the patients taken in the
previous month were used to exclude other reasons.

Ultrasound elastography
High resolution ultrasound system (Aplio™ 400 Platinum, Toshiba Medical Systems Corporation, Tochigi, Japan) and wide band convex probe (PVT-375BT) were used. When the gluteus maximus and piriformis muscles were seen in the same image in the gray scale ultrasound imaging done symmetrically, bilaterally and separately in the posterior aspect of the gluteal region, elastography mode was turned on and pressure was applied (Figure 1). Field of interest (ROI) was used to compare the UE strain value (UESV) of the subcutaneous fat tissue with the UESV of the central parts of the piriformis and gluteus maximus muscles. UE strain ratio (UESR) was calculated by dividing the fat values to the muscle values. All the imaging was performed by the same experienced radiologist blind to the clinical diagnosis.

Statistical Analysis

Relationship of strain rates were analyzed by Spearman’s rho, comparisons were done with Mann-Whitney U test and diagnostic performances were analyzed against the clinical diagnosis by the analysis of the ROC curve.

RESULTS

21 of the cases were female and 7 were female. Their ages changed between 24-62. Median age was 45.

Significant elasticity difference was found between the painless side and the painful side between the piriformis muscles in in UE imaging (Figure 1).

Average UESR values of the clinically PMS diagnosed side (piriformis 1.59±1.21 and median (min/max): 1.30 (0.55/4.86); gluteus maximus 1.01±1.05 and median (min/max): 0.68 (0.25/4.19)) were higher than the normal side values (piriformis 0.56±0.47 and median (min/max): 0.57 (0.02/1.71); gluteus maximus 0.42±0.35 and median (min/max): 0.36 (0.02/1.17)) (correspondingly p=0.000 and p=0.003) (Figure 2). For the UESRs, area under the ROC curve was 0.878 (%95 confidence interval 0.774-0.981) for the piriformis muscle and 0.768 (%95 confidence interval 0.622-0.913) for the gluteus maximus muscle. When UESR was used as 0.765 in the piriformis muscle sensitivity and specificity values were 80.95% and 85.71%. When UESR was used as 0.420 in the gluteus maximus muscle sensitivity and specificity values were 85.71% and 66.67% consecutively.

When 124.62% was used in the piriformis muscle, UESR increase rate when compared to the normal side had sensitivity and specificity values of 100%. When 100.4% was used in the gluteus maximus muscle, UESR increase rate when compared to the normal side had sensitivity of 100% and specificity of 95.24% (Figure 3).
Correlations

There was complete accordance between the disease side piriformis UESR (rho:1.000; p=0.000) and gluteus maximus UESR (rho:1.000; p=0.000) levels in addition to all piriformis UESR and gluteus maximus UESR (rho:1.000; p=0.000). Disease state was more common on the right side (female 62.5%; male 100% and total 71.4%) (rho: -0.788; p=0.000).

As the age increased, left (rho:0.607; p=0.004) and right sides (rho:0.632; p=0.002) increased together. In addition, normal (rho:0.572; p=0.007) and pathologic (rho:0.655; p=0.001) side gluteus maximus UESR increased. The high level of Piriformis UESR in comparison to gluteus maximus UESR decreased gradually (rho: -0.743; p=0.000).

As Muscle UESR values (rho:0.667; p=0.001) and VAS (rho: 0.621; p=0.003) increased, Straight Leg Raise test positivity increased also and mass palpation finding (rho: -0.442; p=0.045) decreased.

DISCUSSION

Three fourths of the 28 patients were female and median age was 45 consistent with the literature (8, 24). Right side dominancy was observed (62.5% in the female patients; 100% in the male patients and71.4% in total). This situation was first described in our study. As the age increased piriformis UESR / Gluteus Maximus UESR ratio increased. As the height increased piriformis UESR and Gluteus Maximus UESR values were higher on the right side. VAS vs. piriformis UESR /Gluteus Maximus UESR ratio and weight vs. piriformis UESR and gluteus maximus UESR values were higher on the left side. Female gender was found to be closely associated with bilaterally. Advanced age, dominant use of the right leg and increase of weight bearing (right dominancy in the population) were thought to affect these variables.

MRI could be useful in diagnosing PMS as it could help make differential diagnosis amongst the other reasons that could cause sciatic nerve syndrome like, lumbar hernia, lumbar stenosis, sacroiliac syndromes and other pathologies around the piriformis muscle. According to the etiology increase in the signal intensity in fluid sensitive sequences, increase in intensity in the piriformis muscle or hypertrophy in muscular volume when compared to the asymptomatic side or sciatic nerve compressed by and accessory piriformis muscle fiber could be seen (6, 25).

Prolonged H reflex was found in the FAIR test done on electromyelography. While the H reflex test of the tibial nerve did not give common satisfaction in the literature for diagnosis, the H reflex of the peroneal nerve should be given more importance, because it demonstrated in our study more specific sign, with six clinical criteria it contributed to improve the method of diagnosis. The cause of this particular syndrome does not only depend on the relation of sciatic nerve and piriformis muscle,
but the environmental conditions should be considered with the series of the anatomical anomalies to explain the real cause of this pain (3, 26).

The diagnosis of the Piriformis syndrome by using UE quantitatively was first described in our study. Although UE is a relatively new diagnostic method its clinical use is rapidly increasing. This technique evaluates the elasticity of the tissues and it is reference to the composition of the tissues (21-23). In muscular pathologies when compared to other tissues, it could be said that without changing the tissue composition their (self) elasticity changes according to the level of contraction (21-23). Contraction which increases as a reflex in pathologic states leads to decrease in elasticity. In our study we discovered that the muscular elasticity decreased in the problematic side. The GM muscle that was evaluated with the Piriformis muscle was found to be affected on the pathologic side and important results were seen that showed that healthier information could be reached by rational comparison.

Laseque, Pace and Freiberg (27) tests are positive in the diagnosis of PMS and the patients have antalgic walking (28, 29). In our cases, these tests were positive on the symptomatic side while they were negative on the asymptomatic side and antalgic walking was observed.

In the early stages PMS could benefit from conservative treatment in 79% of the cases (30). Anti-inflammatory drugs and muscle relaxants can be used (31). Cold application and stretching exercises can be used on the PM (30, 31). During the subacute and the chronic stage heaters from the physical therapy modalities and transdermal neuro-stimulation (TENS) are used (30, 31). Iontophoresis and phonophoresis could be applied (31). Intramuscular local anesthesia or corticosteroid injection could be done in the treatment of PMS. Intramuscular botulinum toxin injection is an effective therapy when physical therapy alone cannot provide enough relief (32). Surgery could be an option in cases where conservative therapy failed. PM is loosened to relieve the pressure on the sciatic nerve and if present fibrous bands are excised. In this method, an incision is made on the hip with the standard posterior approach and the insertion of the tendon of the piriformis muscle is isolated from the greater trochanter (32).

Average muscle UESR values were higher in the PMS diagnosed side when compared to the normal side, when 0.765 was used as the border value in the piriformis muscle sensitivity and specificity values were found to be 80.92% and 85.71% consecutively, when 0.420 was used as the border value sensitivity and specificity values were found to be 85.71% and 66.67% consecutively and area under the ROC curve was found to be 0.878 in the piriformis muscle and 0.768 in the gluteus maximus muscle showed that PMS diagnosis could be efficiently diagnosed by UE. When 124.62% was used in the piriformis muscle UESR increase rate when compared to the normal side had sensitivity and
specificity of 100%. When 100.04% was used in the gluteus maximus muscle UESR increase rate when compared to the normal side had sensitivity of 100% and specificity of 95.24%.

Late diagnosis with MRI and other diagnostic tools is decreasing the treatment success. The main purpose of our study is to use early diagnosis and treatment options to achieve better results. The results we achieved show that we have already reached our target.

Limitations

The low number of cases, lack of a separate control group and lack of UE standard values constitute the limitations of this study. Nonetheless, since this is the pioneer study addressing this issue, we think our study is satisfactory.

Conclusion

Ultrasound elastography is an easy and cheap technique which helps early diagnosis of PMS and aids in less invasive treatment. More advanced and control studies could provide detailed information.
REFERENCES


FIGURE LEGENDS

Figure 1. Ultrasound elastography images of 24-year-old female patient A) B mode and B) elastography mode of right side; C) B mode and D) elastography mode of left side gluteal region.

Figure 2. For A) Piriformis and B) GM muscles, UESR values between pathological and non-pathological sides.

Figure 3. For A) Piriformis and B) GM muscles, percent raise values between pathological and non-pathological sides.