MedicalExpress

RAPID COMMUNICATION

Gluteus Maximus inhibition in proximal hamstring tendinopathy

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OBJECTIVE: The purpose of this study was to demonstrate the inhibition of the ipsilateral Gluteus Maximus in the presence of proximal hamstring tendinopathy and to collect information about its cause.
DESIGN: We studied three subjects with clinical evidence of proximal hamstring tendinopathy previously submitted to conservative treatment with poor results and exhibiting severe hypotrophy and diminished strength in the ipsilateral Gluteus Maximus in comparison with contralateral Gluteus Maximus.
INTERVENTIONS: Patients were submitted to evaluation of the Gluteus Maximus inhibition through handheld dynamometer strength measurements before and during neuromuscular electrical stimulation.
RESULTS: The three subjects exhibited increased strength in the affected Gluteus Maximus (mean 43%; range 27%-62%) when neuromuscular electrical stimulation was added in the evaluations.
CONCLUSION: This study demonstrates that individuals with proximal hamstring tendinopathy present ipsilateral Gluteus Maximus inhibition with hypotrophy and diminished strength. Neuromuscular electrical stimulation partially restores muscular strength. Further studies are required to evaluate the effects of this type of treatment.

KEYWORDS: Hip; Tendinopathy; Muscle Strength Dynamometer; Biomechanics.

Jesus JF, Bryk FF, Moreira VC, Nakaoka GB, Reis AC, Lucareli PRG. Gluteus Maximus inhibition in proximal hamstring tendinopathy. MedicalExpress (São Paulo, online). 2015;2(4):150406

Received for Publication on May 5, 2015; **First review** on May 12, 2015; **Accepted for publication** on June 2, 2015

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INTRODUCTION

In general, tendinopathies are associated with muscular system overload.[1] Although proximal hamstring tendinopathy was described for the first time in the nineteen eighties,[2] and was found to affect athletic as well as the nonathletic populations, its cause still needs to be further clarified.[3]

The signs and symptoms have an insidious onset, worsen over time, and may be caused by an overload of physical activity. Pain in the proximal and posterior region of the thigh in the sitting position is a common complaint.[2,4]

There are studies pointing to a synergism between the Gluteus Maximus and the hamstring muscles during several activities. This implies that Gluteus Maximus weakness promotes hamstring myotendinous overload.[5-8]

Besides these biomechanical features, other studies have shown voluntary muscle recruitment deficits (muscular inhibition) in some musculoskeletal joint injuries. However, it is not common to associate this phenomenon with hip injuries and tendinopathies.[9-11]

Thus, the main objective of this case series was to present Gluteus Maximus strength and muscular inhibition in three individuals with proximal hamstring tendinopathy, in an attempt to improve knowledge about this condition.

METHODS

Authorization to use data, clinical information, and images of the subjects involved in this study was obtained

DOI: 10.5935/MedicalExpress.2015.04.06

through an informed consent form signed by all patients; the institutional ethics committee approved the study under case number 138.939.

The general demographic characteristics and complaints of the three patients reported in this case series are shown in Table 1.

These three patients were positive for hamstring tendinopathy and had presented poor results with previous conservative treatment. They were submitted to medical screening that was negative for any systemic or non-musculoskeletal disease (history of cancer, unexplained changes in weight, recent fever, or trauma). Past medical history was negative for previous surgeries, hypertension, and diabetes mellitus.

A differential diagnosis screening was performed for active, passive, and accessory motion of the lumbar spine, hip, sacroiliac joint, knee and ankle; no joint dysfunction was detected, and none of the subjects complained of pain in association with these movements.

The posterior region of the individuals' thighs was evaluated. First an inspection was made in the complaint side (left thigh) using the asymptomatic side (right thigh) as the parameter of normality. During this examination, an important hypotrophy of the Gluteus Maximus was noted on the left (painful) side when compared with the contralateral asymptomatic side for the three patients.

A palpation exam was performed on the painful thigh. Tenderness was found in the middle portion of the long head of the Biceps Femoris and in the semitendinosus muscles (cases 02 and 03); significant hypotrophy in the left Gluteus Maximus was present in all cases. The left ischial tuberosity was not painful in this examination for any of the patients.

None of the subjects exhibited flexibility deficits; according to information collected they performed regularly a series of hamstring stretches in sports activities.

Gluteus Maximus muscular strength measurement was performed using a handheld Lafayette dynamometer (Lafayette Instrument Company, Lafayette, Indiana, USA). All Gluteus Maximus data were collected by a single physical therapist blinded to which was the painful thigh; this examiner showed excellent reliability according to intraclass correlation coefficients (ICC) = 0.96.[12-14]

Hip extension strength (Gluteus Maximus) was assessed with the individual in prone position on the massage table, with the knee flexed at 90° and hip in slight lateral rotation. Resistance was provided at the distal thigh 5 cm above the popliteal fossa[15]. The handheld dynamometer was stabilized with a strap during these tests so as not to compromise the strength data collection.

During strength testing, two submaximal trials were used to familiarize the subjects with the test. A ten-second rest interval was allowed between the familiarization trials. After 10 more seconds, two maximal isometric contractions were standardized at 5 seconds, with a resting interval of 30 seconds between them. For data analysis, the average values of the 2 maximum effort trials were used.

Evaluation followed this order: the right Gluteus Maximus (asymptomatic) without and with neuromuscular electrical stimulation of medium frequency (NMES), followed by the left Gluteus Maximus (painful) without and with electrical stimulation.

After the evaluation of the right Gluteus Maximus (asymptomatic) without neuromuscular electrical stimulation, a standard one-minute rest period was allowed before evaluating the same muscle with stimulation, and a second one-minute rest period was allowed before the same evaluation on the opposite lower limb (painful). The one-minute rest period was provided before the evaluation of the left Gluteus Maximus with electrical stimulation. When the evaluator observed any compensatory movement during an evaluation, values were disregarded, and the test was repeated after 20 seconds of rest. Strength measurement may be repeated up to three times to avoid excessive overload and pain.

The same verbal command was always used ("GO, GO, GO") to encourage the patients during the strength tests.[15]

Table 1 - General characteristics of included patients

Patient	Gender	Age	Height (cm)	Weight (kg)	Occupation (Description)	Sport (intensity)	Symptom onset	Present complaint
1	male	48	175	72	Computer operator (8 hr/ day, seated)	Weightlifting (light 3x/ week)	2007	Pain, left thigh proximal and posterior region (left ischial tuberosity); VAS = 5.6 - sitting for 5 minutes.
2	male	35	180	88	Computer operator (9 hr/ day, sitting)	Swimming (light 2x/ week)	2009	Pain, left thigh proximal and posterior region (left ischial tuberosity); VAS = 9.0 - sitting for 20 minutes
3	female	51	159	65	Computer operator (9 hr/ day, sitting)	none	2005	Pain, left thigh proximal and posterior region (left ischial tuberosity) VAS = 9.0 - sitting for 15 minutes.

The neuromuscular electrical stimulation equipment was set up with the following parameters: frequency: 70 Hertz; work cycle: 50%; 5 sec turn-on (contraction) followed by a 30 sec turn-off (rest). The electrodes were placed on the Gluteus Maximus muscle belly. The stimulus intensity was increased until the maximum asymptomatic perception was achieved in each patient.

After the strength data collection comparisons were performed for the left Gluteus Maximus without neuromuscular electrical stimulation *versus* the other three measured parameters: left Gluteus Maximus with stimulation and right Gluteus Maximus with and without stimulation.

RESULTS

Taken jointly, the strength measurements exhibited in Figure 1 show that the subjects presented:

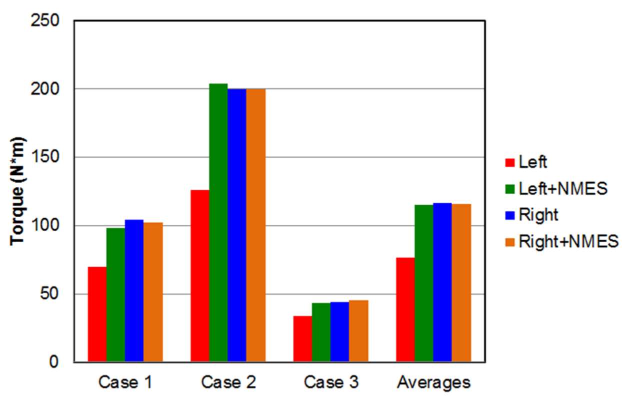

Figure 1 - Subjects' strength (N*m) in all conditions evaluated. Values for three individual and the average show that the non-stimulated left (painful) Gluteus Maximus developed 34% less torque in comparison to the other three measured parameters. NMES: neuromuscular electrical stimulation with the following parameters: frequency: 70 Hertz; work cycle: 50%; 5 sec turn-on (contraction) followed by a 30 sec turn-off (rest).

i No differences for torque developed by the right (healthy) Gluteus Maximus with or without neuromuscular electrical stimulation and for the left (painful) Gluteus Maximus with stimulation

ii An average deficit of 34% for the torque developed by the non-stimulated Left (painful) Gluteus Maximus *versus* the other three measurements.

DISCUSSION

This case series showed Gluteus Maximus inhibition on the affected side of three patients with proximal hamstring tendinopathy.

The three patients complained of pain in the proximal and posterior region of the thigh, especially in a sitting position at work. This is a common clinical sign and is usually associated with tendon morphological changes,[16,17] which may actually be the cause of the primary complaint; however the presence of Gluteus Maximus hypotrophy and decreased muscle cushion may increase pain, because the hamstring tendon would be more exposed to pressure imposed by the sitting position.

Furthermore, proximal hamstring tendinopathy promotes diffuse pain in the proximal and posterior region of the thigh during sport activity.[16,17] This could be correlated with hamstrings and Gluteus Maximus imbalances, which lead to progressive proximal hamstring tendon overload, injury, and pain.[5,7,8,18-20]

Patients in this study also presented this complaint. Although they are non-athletes, Gluteus Maximus inhibition was noted in the painful side; this may have enhanced the hamstring tendon overload during their recreational sports activities.

Muscular inhibition is generally present in several clinical situations associated with pain,[9-11,21,22] such as was the case with the subjects evaluated in this study. This muscular inhibition has been described as a limiting factor in the rehabilitation process. Therefore, an accurate assessment of the muscle's ability to produce force becomes essential.[23]

Handheld dynamometry has shown good results of intra- and inter-observer reliability, as well as in muscular strength test and retest,[24] especially when the evaluations occur with and without neuromuscular electrical stimulation in the muscle to be investigated. The use of such stimulation increases the capacity of the central nervous system to voluntarily activate the muscle. This feature recruits all viable motor units during voluntary muscle contraction. Due to this characteristic, this evaluation protocol was applied in this study.[10,25]

The difficulty of achieving good results with conservative treatment in proximal hamstring tendinopathy may be due to a non recognition of all the biomechanical and physiological features of the subjects enrolled in this study that presented Gluteus Maximus hypotrophy, and led us to investigate Gluteus Maximus inhibition.

Although we have noticed the presence of Gluteus Maximus inhibition in individuals with proximal hamstring tendinopathy, this study presented some limitations, namely the small number of patients, the lack of a functional assessment (specific questionnaires), and the lack of an electomyographical evaluation of Gluteus Maximus activation time. Future research should propose new and more efficient protocols concerning conservative treatment of proximal hamstring tendinopahty.

CONCLUSION

The three patients with proximal hamstring tendinopathy presented Gluteus Maximus inhibition in the painful thigh.

AUTHOR CONTRIBUTIONS:

Jesus JF: data collection, discussion and elaboration of hypotheses, file organizing and writing article; Bryk FF: data collection, discussion and elaboration of hypotheses; revision of text; Moreira VC: discussion and elaboration of hypotheses, file organizing and writing article; Nakaoka GB: data collection, discussion and elaboration of hypotheses, file organizing and writing article; Reis AC: discussion and elaboration of hypotheses,, submission of Project to the ethics committee; Lucareli PRG: discussion and elaboration of hypotheses; revision of text.

CONFLICT OF INTEREST

Authors declare no conflict of interest regarding this publication

INIBIÇÃO DO GLÚTEO MÁXIMO NA TENDINOPATIA PROXIMAL DOS MÚSCULOS ISQUIOTIBIAIS: SÉRIE DE CASOS

OBJETIVO: O objetivo deste estudo foi demonstrar a inibição ipsilateral do glúteo máximo na presença de tendinopatia proximal dos músculos isquiotibiais e coletar informações sobre a causa desta disfunção.

DESENHO: Série de casos.

PARTICIPANTES E INTERVENÇÕES: Três indivíduos com evidências clínicas de tendinopatia proximal dos isquiotibiais previamente submetidos a tratamento conservador com resultados insatisfatórios que apresentaram importante hipotrofia e redução de força no glúteo máximo ipsilateral quando comparado com o contralateral. Os indivíduos foram submetidos a avaliações da inibição do glúteo máximo mediante mensurações de força com e sem eletroestimulação neuromuscular deste músculo.

RESULTADOS: Os três indivíduos exibiram aumento da força do glúteo máximo afetado (media: 43%; 27%-62%) quando a eletroestimulação neuromuscular foi adicionada nas avaliações.

CONCLUSÃO: Este estudo demonstrou que os indivíduos com tendinopatia proximal dos músculos isquiotibiais apresentaram inibição, hipotrofia e redução da força do glúteo máximo ipsilateral. A eletroestimulação neuromuscular restaurou parcialmente a força. Estudos futuros são necessários para avaliar o efeito desta intervenção nos programas de reabilitação.

PALAVRAS-CHAVE: Quadril, Tendinopatia, Dinamômemtro de Força Muscular, Biomecânica.

REFERENCES

1. Andarawis-Puri N, Flatow EL. Tendon fatigue in response to mechanical loading. J Musculoskelet Neuronal Interact. 2011;11(2):106-14.
2. Puranen J, Orava S. The hamstring syndrome. A new diagnosis of gluteal sciatic pain. Am J Sports Med. 1988;16(5):517-21.
3. Lempainen L, Sarimo J, Mattila K, Vaittinen S, Orava S. Proximal hamstring tendinopathy: results of surgical management and histopathologic findings. Am J Sports Med. 2009;37(4):727-34.
4. Kujala UM, Orava S, Järvinen M. Hamstring injuries. Current trends in treatment and prevention. Sports Med. 1997;23(6):397-404.
5. Petersen J, Holmich P. Evidence based prevention of hamstring injuries in sport. Br J Sports Med. 2005;39:319–23.
6. Heiderscheit BC, Sherry MA, Silder A, Chumanov ES, Thelen DG 2010 Hamstring Strain Injuries: Recommendations for Diagnosis, Rehabilitation, and Injury Prevention. J Orthop Sports Phys Ther 40(2):67-81.
7. Larsen KC, Littlewood C, Garth A. Prone hip extension with lower abdominal hollowing improves the relative timing of Gluteus Maximus activation in relation to biceps femoris. Man Ther. 2010;15:61–5.
8. Wagner T, Behnia N, Ancheta WKL, Shen R, Farrokhi S, Powers CM. Strengthening and Neuromuscular Reeducation of the Gluteus Maximus in a Triathlete With Exercise-Associated Cramping of the Hamstrings. J Orthop Sports Phys Ther. 2010;40(2):112-9.
9. Palmieri-Smith RM, Kreinbrink J, Ashton-Miller JA, Wojtys EM. Quadriceps inhibition induced by an experimental knee joint effusion affects knee joint mechanics during a single-legged drop landing. Am J Sports Med. 2007;35(8):1269-75.
10. Reinold MM, Macrina LC, Wilk KE, Dugas JR, Cain EL, Andrews JR. The effect of neuromuscular electrical stimulation of the infraspinatus on shoulder external rotation force production after rotator cuff repair surgery. Am J Sports Med. 2008;36(12):2317-21.
11. Palmieri-Smith RM, Hopkins JT, Brown TN. Peroneal activation deficits in persons with functional ankle instability. Am J Sports Med. 2009;37(5):982-8.
12. Bohannon RW. Hand-held compared with isokinetic dynamometry for measurement of static knee extension torque (parallel reliability of dynamometers). Clin Phys Physiol Meas. 1990;11:217-22.
13. Andrews AW, Thomas MW, Bohannon RW. Normative values for isometric muscle force measurements obtained with hand-held dynamometers. Phys Ther. 1996;76:248-59.
14. Piva SR, Goodnite EA, Childs JD. Strength around the hip and flexibility of soft tissues in individuals with and without patellofemoral pain syndrome. J Orthop Sports Phys Ther. 2005;35:793-801.
15. Magalhães E, Fukuda TY, Sacramento SN, Forgas A, Cohen M, Abdalla RJ. A Comparison of Hip Strength Between Sedentary Females With and Without Patellofemoral Pain Syndrome. J Orthop Sports Phys Ther. 2010;40(10):641-7.
16. Sharma P, Maffulli N. Biology of tendon injury: healing, modeling andremodeling. J Musculoskelet Neuronal Interact. 2006;6:181-90.
17. Cacchio A, Rompe JD, Furia JP, Susi P, Santilli V, De Paulis F. Shockwave therapy for the treatment of chronic proximal hamstring tendinopathy in professional athletes. Am J Sports Med. 2011;39(1):146-53.
18. Askling C, Saartok T, Thorstensson A. Type of acute hamstring strain affects flexibility, strength, and time to return to pre-injury level. Br J Sports Med. 2006;40(1):40-4.
19. Askling CM, Tengvar M, Saartok T, Thorstensson A. Acute first-time hamstring strains during slow-speed stretching: clinical, magnetic resonance imaging, and recovery characteristics. Am J Sports Med. 2007;35(10):1716-24.
20. Askling CM, Tengvar M, Saartok T, Thorstensson A. Proximal hamstring strains of stretching type in different sports: injury situations, clinical and magnetic resonance imaging characteristics, and return to sport. Am J Sports Med. 2008;36(9):1799-804.

21. Herzog W, Suter E. Muscle inhibition following knee injury and disease. Sportverletz Sportschaden. 1997;11:74-8.
22. Hopkins JT, Brown TN, Christensen L, Palmieri-Smith RM. Deficits in peroneal latency and electromechanical delay in patients with functional ankle instability. J Orthop Res. 2009;27(12):1541-6.
23. Hopkins JT, Ingersoll D. Arthrogenic muscle inhibition: a limiting factor in joint rehabilitation. J Sports Rehabil. 2000;9:135-59.
24. Fulcher ML, Hanna CM, Raina Elley C. Reliability of handheld dynamometry in assessment of hip strength in adult male football players. J Sci Med Sport. 2010;13(1):80-4.
25. Kean CO, Birmingham TB, Garland SJ, Bryant DM, Giffin JR. Minimal detectable change in quadriceps strength and voluntary muscle activation in patients with knee osteoarthritis. Arch Phys Med Rehabil. 2010;91(9):1447-51.