Do Neuromuscular Alterations Exist for Patients With Acetabular Labral Tears During Function?

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Purpose: To determine if contact forces and electromyography (EMG) muscle amplitudes were altered during the lunge for patients with symptomatic labral tears compared with asymptomatic control subjects. **Methods:** Surface electromyography electrodes were placed over the gluteus medius, gluteus maximus, adductor longus, and rectus femoris muscles of the patients' involved limb and matched limb of asymptomatic controls. Subjects performed 3 trials of the lunge on a clinical force platform. An electrogoniometer tracked knee flexion motion during testing. Average root mean squared EMG muscle amplitudes for each muscle were calculated for the descent and ascent phases of the lunge, represented as a percentage of maximum activity (%MVIC). Peak knee flexion was calculated from the goniometer (°). The dependent variables from the force platform were lunge distance (%height), contact time (seconds), vertical impact force (%BW), and force impulse (%BW*s). Dependent variables were compared between groups using either independent samples *t* tests or Mann-Whitney *U* tests. Relations between dependent variables were assessed with Spearman Rho correlation coefficients. The level of significance was set at $P \leq .05$. **Results:** Twenty-one patients with symptomatic unilateral labral tears (14 females, 7 males) and 17 asymptomatic control subjects (11 females, 6 males) participated in this study. Average gluteus maximus EMG muscle amplitudes were reduced for symptomatic labral patients compared with asymptomatic controls during lunge ascent (51.6 ± 31.1 *v* 71.7 ± 36.3 [mean difference (MD): 20.1% (−2.4%, 42.6%)], $P = .042$). Average vertical impact force was reduced (21.8 ± 5.5 *v* 26.8 ± 7.3 [MD: 5.1%BW (0.84%BW, 9.3%BW)], $P = .02$) and average contact time (1.8 ± 0.4 *v* 1.5 ± 0.4 [MD: 0.27 seconds (0.006 seconds, 0.54 seconds)], $P = .045$) and force impulse (188.4 ± 42.4 *v* 162.6 ± 33.3 [MD: 25.8%BW*s (0.3%BW*s, 51.4%BW*s)], $P = .042$) were increased for symptomatic labral patients compared with asymptomatic controls. Vertical impact force was inversely correlated with gluteus medius muscle amplitudes during lunge descent for symptomatic labral patients ($r = -0.452$, $P = .045$). **Conclusions:** Our study shows that contact forces and EMG muscle amplitudes are altered during the lunge for patients with symptomatic labral tears. The presence of a relation between muscle amplitudes and contact forces suggests that targeting muscle impairments may restore function in these patients. **Level of Evidence:** Level III, case-control study.

Acetabular labral tears are a common source of intractable hip pain. Improvements in our understanding of the clinical presentation of patients, along with advancements in imaging techniques, has allowed for earlier detection and treatment of intra-articular hip conditions. For patients with intra-articular hip pathology, pain and mechanical symptoms are commonly reported,[1-3] which limit their ability to perform their desired activities.[4,5] However, identification of the specific functional impairments experienced by these patients is limited. Quantifying muscle and joint function in patients who have acetabular labral tears is critical to determining appropriate treatment plans and assessing the ability of surgical intervention to restore function in this population.

Traditionally, quantifying function in patients with labral pathology has been limited to the use of patient-reported outcome measures.[6-11] Although these measures are invaluable to providing an overall assessment of subjective pain and function in these patients,[12-15] the use of outcome scores for such measures has limited our ability to identify the specific muscle impairments that contribute to the functional limitations reported by patients and, more importantly, determine

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the causes of these limitations. Recently, measures of hip muscle strength in patients undergoing hip arthroscopy were reported.[16,17] Specific deficits in hip flexion and abduction strength were noted in patients, and the reduction in hip flexion strength was found to be associated with a decrease in both flexion range of motion and patient-reported function, as measured by the modified Harris Hip Score. Although these initial reports provide valuable initial insight into a potential contributor to poor function in these patients, the specific impact that muscle impairment has on joint function in patients with labral pathology is unknown. Identification of the specific muscle impairments present during function in patients with labral tears is imperative to developing appropriate, evidence-based treatment programs.

The aim of our study was to compare electromyographic (EMG) muscle activation patterns and clinical force measurements during the performance of the lunge between patients with symptomatic unilateral acetabular labral tears and asymptomatic control subjects. We hypothesized that patients with symptomatic acetabular labral tears would have alterations in average EMG amplitudes of the periarticular muscles of the hip and altered force and timing variables during the lunge compared with asymptomatic control subjects. In addition, we hypothesized that the alterations in EMG muscle amplitudes would correlate to the observed changes in lower extremity movement patterns and loading.

Methods

Between May 2014 and May 2015, we assessed EMG muscle activation patterns and clinical force measures during a lunge in patients with symptomatic unilateral acetabular labral tears and asymptomatic control subjects. Our study was retrospective, with prospectively collected data. Individuals with a tear of the acetabular labrum were recruited from the patient population of our center. Patients were included if they presented with current unilateral hip pain; positive clinical symptoms, including anterior groin pain and mechanical symptoms of clicking and/or locking in the hip; positive clinical tests, including flexion-adduction-internal rotation, McCarthy sign[18]; a tear of the acetabular labrum, as confirmed by MRI arthrography; were between 18 and 60 years of age; and presented with no major comorbidities. Patients were recruited consecutively and included if they met the exclusion criteria and agreed to participate. Subjects were excluded if they had symptomatic bilateral hip pain; had undergone a previous hip arthroscopy; had a history of previous major knee or ankle surgery; had current back, knee, or ankle pain; had any history of muscle impairment; or had an adhesive allergy. Asymptomatic control subjects were recruited from the local area via word of mouth. Subjects were considered for the asymptomatic control group if they were between 18 and 60 years of age; had no previous history of hip pain or injury; had normal ranges of hip motion, specifically into internal rotation; had no positive clinical findings during the impingement test or flexion-adduction-internal rotation test; had no current pain in any lower extremity joint; and had no history of major lower extremity injury or surgery. This research study was approved by the institutional review board at our institution. All participants signed a written informed consent form prior to participation.

A 16-lead EMG system (Biopac Systems) was used to record muscle activity. Unit specifications include an amplifier gain of 2,000 Hz, an input impedance of 2 MΩ, and a common mode rejection ratio of 110 dB. Muscle activation of the gluteus medius (GMD), gluteus maximus (GMX), adductor longus (ADD), and rectus femoris (RF) muscles were collected unilaterally for each subject using bipolar Ag-AgCl surface electrodes (Ambu, Glen Burnie, MD) measuring 5 mm in diameter with a center-to-center distance of approximately 2.0 cm. Data were collected from muscles on the involved limb of the patients and a matched limb of the asymptomatic control subjects. The asymptomatic control subjects were matched to a symptomatic labral patient of equal sex and similar age. Prior to electrode placement, the skin was prepared by dry-shaving the area, abrading the area with sandpaper, and cleansing it with alcohol to reduce impedance. Electrodes were placed in parallel arrangement over the muscle belly for each muscle, as described by Cram et al.[19] Electrodes were secured to the skin using Cover-Roll (Beiersdorf-Jobst, Charlotte, NC). To determine accurate electrode placement, the subject was instructed to contract each muscle being tested, whereas EMG activity was observed using the oscilloscope. EMG data were sampled at 1,000 Hz and analyzed using Acq*Knowledge* software (Biopac Systems). A dual-axis goniometer (Biopac Systems) was calibrated and attached to the testing limb to assess sagittal plane knee motion during the activities. Goniometer data were collected at 1,000 Hz and synchronized with the EMG data using Acq*Knowledge* software.

Impact force data were collected during the lunge using the long force platform of the Neurocom Balance Master (Neurocom, Clackamas, OR) connected to a desktop computer. The computer receives the input regarding forces, timing, and distance from the force plate; analyzes the data; and generates a screen display and printed report. Dependent variables calculated during the lunge were lunge distance, contact time, vertical impact force, and force impulse. Lunge distance was defined as the average length of the forward step, expressed as a percentage of each subject's height. Contact time was defined as the average duration of contact with the force platform during the forward step,