Research Paper Review

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Which Exercises Target the Gluteal Muscles While Minimizing Activation of the Tensor Fascia Lata? Electromyographic Assessment Using Fine-Wire Electrodes

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Selkowitz DM, Beneck GJ & Powers CM

Reviewed by Dr. Jeff Muir DC (Research Review Service)

ABSTRACT

Study Design

Controlled laboratory study, repeated-measures design.

Objectives

To compare hip abductor muscle activity during selected exercises using fine-wire electromyography, and to determine which exercises are best for activating the gluteus medius and the superior portion of the gluteus maximus, while minimizing activity of the tensor fascia lata (TFL).

Background

Abnormal hip kinematics (ie, excessive hip adduction and internal rotation) has been linked to certain musculoskeletal disorders. The TFL is a hip abductor, but it also internally rotates the hip. As such, it may be important to select exercises that activate the gluteal hip abductors while minimizing activation of the TFL.

Methods

Twenty healthy persons participated. Electromyographic signals were obtained from the gluteus medius, superior gluteus maximus, and TFL muscles using fine-wire electrodes as subjects performed 11 different exercises. Normalized electromyographic signal amplitude was compared among muscles for each exercise, using multiple 1-way repeated-measures analyses of variance. A descriptive gluteal-to-TFL muscle activation index was used to identify preferred exercises for recruiting the gluteal muscles while minimizing TFL activity.

Results

Both gluteal muscles were significantly ($P<.05$) more active than the TFL in unilateral and bilateral bridging, quadruped hip extension (knee flexed and extending), the clam, sidestepping, and squatting. The

gluteal-to-TFL muscle activation index ranged from 18 to 115 and was highest for the clam (115), sidestep (64), unilateral bridge (59), and both quadruped exercises (50).

Conclusion

If the goal of rehabilitation is to preferentially activate the gluteal muscles while minimizing TFL activation, then the clam, sidestep, unilateral bridge, and both quadruped hip extension exercises would appear to be the most appropriate.

ANALYSIS

Author's Affiliations

Department of Physical Therapy, Western University of Health Sciences, Pomona, California; Department of Physical Therapy, California State University, Long Beach; Jacquelin Perry Musculoskeletal Biomechanics Research Laboratory, Division of Biokinesiology & Physical Therapy, University of Southern California, Los Angeles, California

Background Information

Abnormal hip kinematics and impaired hip muscle performance have been associated with various musculoskeletal disorders, such as patellofemoral pain syndrome (1), iliotibial band syndrome (2), anterior cruciate ligament injuries (3), low back pain (4), and hip joint pathology. Weakness in movements such as hip abduction, external rotation and extension, with increases in hip internal rotation and knee abduction, are associated with patellofemoral pathologies (we have covered much of this literature on RRS). As a result, rehabilitation programs have increasingly focused on hip muscle strengthening.

The gluteal musculature is at the root of hip strengthening programs, which generally focus on exercises such as the side bridge, wall squat, forward step-up, quadruped upper and lower extremity lift, standing hip abduction (weight bearing on the target/opposite extremity), and side-lying hip abduction, to name a few.

Studies focusing on these muscles have, until now, mainly analyzed muscle activity via surface EMG. The use of surface electrodes to detect muscle activity, though, has the potential to contaminate the desired muscle's EMG signal with that of nearby muscles (referred to as 'cross-talk'). In the current study, the authors sought to determine those hip rehabilitation exercises that best focused on gluteal muscle activation without simultaneously involved the counter-active muscle, the TFL. They used fine-wire EMG to provide a more accurate reading of muscle activity and to minimize cross-talk between muscles.

SUMMARY

Exercises tested: Side-lying hip abduction (ABD); bilateral bridge (BiBRG); clam (CLAM); hip hike (HIKE); lunge (LUNGE); quad hip extension, knee extended (QKE); quad hip extension, knee flexed (QKF); sidestep (SIDESTEP); squat (SQUAT); step-up (STEP-UP); and unilateral bridge (UiBRG).

Muscles tested: Superior gluteus maximus, gluteus medius and tensor fascia lata.

Analysis: involved a 3-way ANOVA analysis comparing gender, exercise and muscle activation.

The following exercises demonstrated statistically significant differences between activity in the muscles tested: ABD ($P < 0.001$), BiBRG ($P < 0.001$), CLAM ($P < 0.001$), HIKE ($P < 0.001$), QKE ($P = 0.002$), QKF ($P = 0.003$), SIDESTEP ($P < 0.001$), SQUAT ($P = 0.001$), and UniBRG ($P = 0.004$).

For all of the exercises in which the ANOVA was significant, with the exception of ABD and HIKE, contrast test results revealed that both the GMED and SUP-GMAX had significantly higher normalized EMG amplitudes than the TFL.

For ABD, the normalized EMG amplitude for the GMED was significantly greater than the TFL ($P = 0.012$); however, the SUP-GMAX was significantly less than the TFL ($P = 0.033$). For HIKE, the normalized EMG amplitude for the GMED was not significantly different from the TFL ($P = 0.196$); however, the SUP-GMAX was significantly less than the TFL ($P = 0.001$).

The authors calculated a gluteal-to-tensor-fascia-lata activation index (GTA) to provide an indicator of muscle activation relative to TFL activity. A threshold of 50 was set as clinically valuable (threshold established by parametric statistical testing as a suitable threshold). The results are as follows (* = statistical significance): CLAM* = 115, SIDESTEP* = 64, UiBRG* = 59, QKE* = 50, QKF* = 50, ABD = 38, STEP-UP = 32, BiBRG* = 32, SQUAT* = 28, HIKE = 28, LUNGE = 18.

CLINICAL APPLICATION & CONCLUSIONS

The majority of the exercises evaluated preferentially activated the gluteal muscles while limiting recruitment of the TFL, including QKF, QKE, UniBRG, BiBRG, SQUAT, SIDESTEP, and CLAM. All produced greater than 50% EMG signal from the gluteal muscles, as compared to the TFL. This is useful clinical information we can apply in our offices right away!

During ABD, only the GMED exhibited significantly greater normalized EMG amplitude than the TFL. For the STEP-UP, LUNGE, and HIKE, normalized EMG amplitudes of the gluteal muscles and the TFL were not statistically different, with the exception of the SUP-GMAX, which exhibited lower normalized EMG amplitude compared to the TFL during HIKE. While this may seem to indicate that these exercises are sufficient to avoid counter-productive activation of the TFL during hip exercises, another consideration when making exercise recommendations is the actual normalized EMG amplitude levels of the muscles during the different exercises.

Of the 7 exercises in which both gluteal muscles showed significantly greater EMG amplitude than the TFL, the BiBRG and SQUAT produced relatively low normalized EMG amplitudes of both the

GMED and SUP-GMAX. Using the GTA Index, of the exercises examined, the CLAM, SIDESTEP, UniBRG, QKE, and QKF exercises had GTA index values of 50 or greater. These exercises, then, appeared to be the most desirable to produce high levels of GMED and SUP-GMAX activity, while minimizing activation of the TFL

Conclusion: When the goal of rehabilitation is to preferentially activate the gluteal muscles while minimizing TFL activation then the CLAM, SIDESTEP, UniBRG, QKE, and QKF exercises appear to be most appropriate.

STUDY METHODS

Participants

20 healthy volunteers (10 men and 10 women) between the ages of 18 and 50 years (mean + SD age, 27.9 + 6.2 years) participated in the study.

EMG Evaluation

EMG data were collected using an MA- 300-16 EMG system. The fine-wire electrodes consisted of pairs of pre-sterilized, disposable, 50-?m nickel-chromium alloy wires, nylon-insulated except for 2 mm of exposed wire at their ends, which were inserted into the muscle.

Exercises

Subjects performed 11 exercises in a random order: hip abduction in side-lying (ABD), clam with elastic resistance around thighs (CLAM), bilateral bridge (BiBRG), unilateral (single-leg) bridge (UniBRG), hip extension in quadruped on elbows with knee extended (QKE), hip extension in quadruped on elbows with knee flexed (QKF), forward lunge with erect trunk (LUNGE), squat (SQUAT), sidestep with elastic resistance around thighs in a squatted position (SIDESTEP), hip hike (HIKE), and forward step-up (STEP-UP).

STUDY STRENGTHS / WEAKNESSES

Limitations:

- The CLAM and SIDESTEP exercises used elastic resistance that was not quantified in absolute or relative terms. It is possible that without the added resistance, these exercises would have had lower normalized EMG amplitudes and GTA indexes.
- This study was performed on a sample of healthy, uninjured individuals. Whether the findings may be generalized to specific patient populations remains to be seen.
- The authors did not quantify activation of the gluteus minimus, which represents approximately 20% of the total hip abductor cross-sectional area.

Strengths:

- The authors addressed the most widely used hip rehabilitation exercises, providing applicable data for clinical practice.
- The authors' EMG measurements using fine-wire technology were more specific and less likely to suffer from cross-talk than surface EMG measurements.

Additional References

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