

# Electromyographic Analysis of Various Hip Exercises in Normal Subjects

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**Abstract.** The goal was to compare electromyography (EMG) activity of the gluteus medius muscle during 5 weight bearing exercises. Our subjects consisted of 30 healthy volunteers (mean age 24.30 years, height 173.31 cm, weight 71.67 kg). Subjects performed a dynamic warm-up, followed by collection of gluteus medius EMG muscle activity while performing 3 trials of each of 5 exercises (randomized), with 30 seconds rest between exercises. Subjects performed all exercises in a single session. The EMG activity during exercise was compared to the MVIC (maximum voluntary isometric contraction) to give a percent MVIC for each exercise. The results of our study can be used by physical therapists to determine which exercise(s) would be most beneficial for strengthening of the gluteus medius.

## 1. Introduction

Our study aims to determine which exercises isolate the gluteus medius. To determine which exercises produce the greatest muscle activity, we will be using EMG. It is assumed that a higher EMG signal indicates greater muscle activation and that all participants will be exerting max force during a given exercise. Research has compared weight bearing and non-weight bearing exercises to see which result in greater activation of the gluteus medius. To our knowledge, there are no studies comparing activation levels of specific weight bearing exercises on the gluteus medius to see which exercise elicits the highest EMG readings. We are also unaware of any research studies that investigated EMG activity of the gluteus medius during the speed skater exercise. The purpose of our study is to investigate the EMG activity of the gluteus medius muscle of the hip during various exercises. We hypothesized that the unilateral bridge with leg off test surface would result in the greatest gluteus medius activation.

## 2. Experiment, Results, Discussion, and Significance

### Procedure

Each subject participated in a 7 minute dynamic warm up consisting of a single knee to chest march, lunges, toy soldier, spider man lunges, lateral/medial leg swing, hurdle lunges, and anterior/posterior leg swing. After the warm up, the subjects rested for 5 minutes prior to the MVIC testing. During the rest period, the principal investigator prepared the subject's skin for the surface EMG electrodes in a standard manner. Surface Ag-AgCl electrodes were placed over the gluteus medius of the subject's dominant leg (leg they would use to kick a ball for max distance), parallel to the muscle fibers over the proximal third of the distance between the iliac crest and the greater trochanter. This location was chosen to minimize crosstalk and maximize the recording activity of the motor unit [6]. Ground electrodes were placed on the contralateral ASIS and rectus abdominus.

For MVIC testing, the subject was sideling on non-dominant side with the dominant hip in neutral. The subject resisted hip abduction against a handheld dynamometer in 3 trials for 3 seconds each and EMG activity and dynamometer readings were recorded for each trial. Strong verbal encouragement was given to ensure maximal effort. Subject was given a 30 second rest period after each trial. Following MVIC testing, the subject performed three trials of each of the five exercises in a randomized order with a 30 second rest period between trials. The exercises performed included the following: single leg bridge, single leg bridge with foot below test surface, single leg pull through lunge, single leg reverse stationary lunge and speed skater. EMG activity of the gluteus medius muscle was recorded, analyzed by smoothing, and divided by the maximum EMG values obtained from the MVIC reading. We used the percent MVIC to determine which of the five exercises resulted in the greatest activity of the gluteus medius muscle.

### Results

Table 1: Exercises Ranked in Order from Most to Least Percentage of MVIC of Gluteus Medius

Rank	Exercise	%MVIC
1	Reverse Unilateral Lunge	55.49 ± 21.72
2	Unilateral Bridge with Leg off Test Surface	51.33 ± 20.16
3	Unilateral Bridge	47.37 ± 20.84
4	Unilateral Leg Lunge	37.32 ± 14.40
5	Speed Skater	35.54 ± 20.76

\*Results in (%MVIC  $\pm$  SD format)

### Discussion

Our data shows that the single leg reverse lunge resulted in the highest %MVIC, while the unilateral bridge with leg off test surface resulted in the second highest activation. We expected that these two exercises would rank high among the other exercises. The fact that the speed skater exercise resulted in the least amount of gluteus medius activation was an unexpected result of our study. Given that one of the main actions of the gluteus medius is to stabilize the contralateral hip during single leg stance, we expected that the speed skater would result in much higher EMG activation. A reason for this unexpected result could be the large amount of balance and proprioception required to perform the speed skater exercise correctly. If the subject let their non-test hip drop during the exercise, this would cause the test-side gluteus medius to be put on a stretch, resulting in less activation due to passive insufficiency.

### Significance

Our findings are clinically relevant when developing an exercise progression protocol in the rehabilitation setting focusing on the strengthening of gluteus medius. Patients with Trendelenberg gait would benefit from a gluteus medius strengthening protocol. Also, athletes participating in sports that have higher rate of ACL injury would benefit from strengthening the hip musculature[8]. The speed skater and unilateral leg lunge exercises required the least amount of muscle activity. Therefore, weaker patients may be able to utilize these exercises early in rehab. It should be noted that these exercises require appropriate balance and proprioception. As patients become proficient in the speed skater and unilateral leg lunge exercises, they may progress to the higher level exercises.

### 3. Conclusions

This study indicated relative differences in hip abductor EMG activity during various hip exercises. Speed skater exercises required less gluteus medius activation; therefore, these exercises may benefit patients early in the gluteus medius strengthening protocol. Reverse unilateral leg lunges applied the greatest amount of hip activation; therefore, these exercises would be appropriate later in the progression of gluteus medius strengthening. Results from this study demonstrated a progression of hip abductor muscle activity among common therapeutic exercises.

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