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Quadriceps and gluteus medius activation with increasing task speed during a lateral step-down

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Background

- Clinically, slower task performance is thought to increase task demands. Interestingly, few studies have explored altering task rate on electromyographic (EMG) muscle activity, particularly in the lower extremity.

Purpose

- The purpose of this study was to compare the effects of three task rates during a lateral step-down (LSD) on muscle activation of the vastus lateralis (VL) and gluteus medius (GM) using two activation metrics.

Hypothesis

- We hypothesized that slower task performance would increase the activation demands of the VL and GM.

Subjects

- 15 healthy individuals (10 females, age = 23.5 ± 0.7 years, body mass index = 25.0 ± 4.3 kg/m^2; 5 males, age = 25.2 ± 2.7 years, body mass index = 26.1 ± 4.8 kg/m^2)

Methods

Data Collection

- Subjects were tested unilaterally, using random selection of test limb. Electrodes were placed over the vastus lateralis and gluteus medius.
- Maximum isometric voluntary contractions (MVC) were collected for both muscles.
- For the LSD, subjects stood with the test limb fully extended atop a 6 inch box, lowered the contralateral limb to the floor to make heel contact, and then returned to full knee extension 6 times (Figure 1).
- Three conditions were tested: 45, 60, and 75 beats per minute (bpm), with each descent or ascent matched to a single metronome beat.

Table 1: Subject descriptive data

	Males (N = 5)	Females (N =10)
Age (years)	25.2 ± 2.7	23.5 ± 0.7
Height (m)	1.8 ± 0.1	1.7 ± 0.1
Weight (kg)	83.9 ± 16.0	66.8 ± 13.4
BMI (kg/m^2)	26.1 ± 4.77	25.0 ± 4.3

Figure 1: Fig. 1a depicts beginning of step down repetition. Fig. 1b demonstrates end of step down repetition when heel contacts the force plate and then returns to start position.

Table 2: VL Peak/Integrated Averages

	45 HZ	60 HZ	75 HZ
VL Peak	2.3 ± 1.1 µv *	2.6 ± 1.5 µv	2.6 ± 1.4 µv **
VL integrated	2.6 ± 1.4 µv **	2.2 ± 1.2 µv **	1.8 ± 1.0 µv **
%MVC peak	230%	260%	260%
%MVC integrated	260%	220%	190%

Voltage values were normalized to MVC of each corresponding frequency for both VL peak and VL integrated.
** = p ≤ 0.008, * = p ≤ 0.01.

Table 3: GM Peak/Integrated Averages

	45 HZ	60 HZ	75 HZ
GM peak	1.5 ± 0.7 µv **	2.9 ± 4.8 µv **	1.6 ± 1.0 µv **
GM integrated	1.5 ± 0.7 µv *	1.1 ± 0.5 µv *	1.0 ± 0.4 µv*
%MVC peak	130%	150%	160%
%MVC integrated	150%	110%	100%

Voltage values were normalized to MVC of each corresponding frequency for both GM peak and GM integrated.
** = p ≤ 0.040, * = p ≤ 0.023

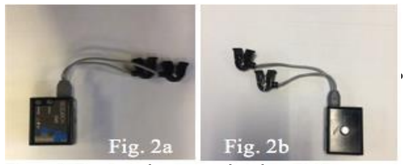

Figure 2: Fig. 2a is front part of surface EMG sensor. Fig. 2b is aspect of surface EMG sensor that touches skin.

Table 4: EMG data description

	Range (µv)	Mean (µv)
45 HZ VL Peak	0.6 - 4.5	2.3 ± 1.1
45 HZ GM Peak	03 - 2.1	1.3 ± 0.6
45 HZ VL Integrated Normalized	0.6 - 5.8	2.6 ± 1.4
45 HZ GM Integrated Normalized	0.2 - 2.4	1.5 ± 0.7
60 HZ VL Peak	0.7 - 5.8	2.6 ± 1.5
60 HZ GM Peak	0.5 - 17.1	2.9 ± 4.8
60 HZ VL Integrated Normalized	0.5 - 5.1	2.2 ± 1.2
60 HZ GM Integrated Normalized	0.3 - 14.0	2.3 ± 3.9
75 HZ VL Peak	0.7 - 5.1	2.6 ± 1.4
75 HZ GM Peak	0.8 - 4.1	1.6 ± 1.0
75 HZ VL Integrated Normalized	0.4 - 4.0	1.8 ± 1.0
75 HZ GM Integrated Normalized	0.4 - 1.8	1.0 ± 0.4

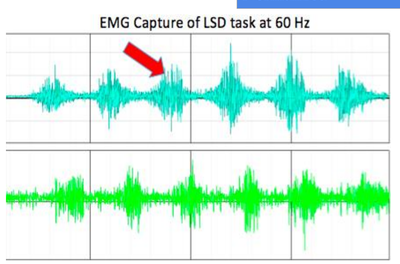

Figure 3: The red arrow indicates muscle activity of the VL during a repetition of a LSD and the bottom picture indicates activity of the GM during a LSD performed at 60 Hz.

Methods

Data Analysis

- The middle four repetitions were extracted from each condition and raw EMG data exported for post-processing using custom MATLAB code.
- Raw EMG data were high-pass filtered, demeaned, rectified, and then low-pass filtered. Average (aEMG) and integrated (iEMG) magnitudes were generated, then normalized to MVCs.
- Conditions were compared using repeated measures analysis of variance (alpha = 0.05).

Results

- For VL aEMG, activation was less at 45 bpm than for both 60 (p=0.010) and 75 bpm (p=0.008), with 60 not different than 75 bpm (p=0.230). For VL iEMG, activation was greatest at 45 bpm, followed by 60 bpm, then by 75 bpm, with all conditions differing (p≤0.008).
- For GM aEMG, activation was less at 45 and 60 bpm compared to 75 (p≤0.040). For GM iEMG, activation was greatest at 45 bpm, followed by 60 bpm then by 75, with all conditions differing (p≤0.023).

Conclusion

- For both muscles, the iEMG data suggest that slower task performance elicits increased activation. However, the aEMG data suggest that faster task performance elicits higher activation potential.

Clinical Relevance

- When performing tasks more slowly, activation demands increase based on the combination of magnitude and duration of the task as evidenced by the iEMG reading. However, these EMG differences disappear without consideration for task duration.

References

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