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Is EMG Muscle Activity in the Lower Extremity Altered in Individuals with Chronically Unstable Ankles During Functional Tests? A Pilot Study

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BACKGROUND

The stability of the ankle relies heavily on the proper function of mechanical and sensory structures, like: muscles, ligaments, tendons, muscle spindles, and Golgi tendon organs. The ankle joint may become clinically unstable with compromise to any of the previously mentioned structures acting as stabilizers to the ankle joint.

For individuals sustaining a single ankle injury, 20-80% will have recurrent injuries or experience instability of the ankle, known as chronic or functional ankle instability (CAI or FAI).*(Benesch, Putz et al. 2000; Linford, Hopkins et al. 2006; Mitchell, Dyson et al. 2008; Mitchell, Dyson et al. 2008; Sefton, Hicks-Little et al. 2008; Hopkins, Brown et al. 2009; Sefton, Hicks-Little et al. 2009; Laudner and Koschnitzky 2010)*

There is currently no "gold standard" for the diagnosis of CAI; however, there are valid and reliable self-report outcome measures such as the Cumberland Ankle Instability Tool (CAIT) and the Ankle Instability Instrument (AII) that are indicated for this diagnosis.*(Docherty, Gansneder et al. 2006; Donahue, Simon et al. 2011)*

Electromyography (EMG) has been used to map the electrical activation properties of muscles for stabilization of the ankle joint. EMG output helps to present a graphical image of electrical activity of the muscle(s) being tested. The primary components of EMG include the amplitude of the action potential, which is indicative of the number of motor units being recruited; timing of muscle firing compared to activity; and the shape of the waves, indicative of the type of fiber being activated.*(Henry, Fung et al. 1998; Morey-Klapsing, Arampatzis et al. 2005; Ty Hopkins, McLoda et al. 2007; Mitchell, Dyson et al. 2008; Hopkins, Brown et al. 2009)*

The most common ankle neuromuscular deficits observed through EMG analysis during isolated static positions, such as postural sway, have been decreased muscle activation, primarily in the evertor muscles of the lower leg,*(de Noronha, Refshauge et al. 2008; Mitchell, Dyson et al. 2008)* and decreased somatosensation in the ankle.*(Morey-Klapsing, Arampatzis et al. 2005; Mitchell, Dyson et al. 2008; Sefton, Hicks-Little et al. 2009)* One study focused on muscle activation of PeroneusLongus (PL), Tibialis Anterior and the lateral head of the Gastrocnemius in volleyball players during a lateral step activity. *(Suda and Sacco 2011)* These authors identified a decrease in PL activation prior to ground impact; a decrease in peak magnitude in PL compared to the control group; and an increased peak magnitude for the lateral head of the Gastrocnemius.

PURPOSE

To determine if there are any differences in lower leg muscle activation, as observed by mean or peak %MVIC with EMG analysis, during functional testing in individuals identified with chronic ankle instability (CAI) as compared to healthy controls

Research Hypothesis: There is a difference in observed EMG muscle activity during functional testing in individuals with CAI when compared to a Control group of individuals with normal, uninjured ankles.

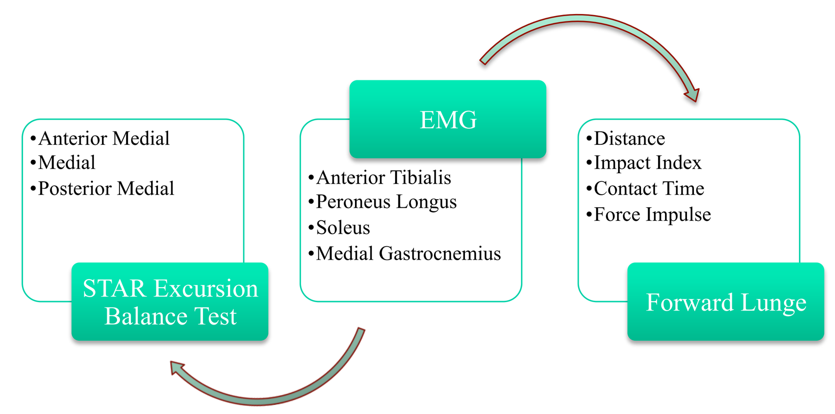
METHODS

Case-control study design
- Case: Presence of ankle instability as identified by the CAIT and AII
- Control: Normal/healthy group without history of ankle injury

20 Subjects recruited for the study
- 8 subjects in unstable ankle group: (5 men, 3 women; mean age 27.6 ± 3.8 years)
- 8 subjects in healthy ankle group: (2 men, 6 women; mean age 27.1 ± 3.6 years)

EMG surface electrodes placed on bilateral lower leg muscles:
- Anterior Tibialis; PeroneusLongus; Gastrocnemius- medial head; Soleus

Figure 1: Muscle activity recorded during functional tests.



The independent variables were the groups (Control & CAI). The dependent variables were the outcomes from the CAIT and the AII, the muscle EMG activities, and measured performance on the functional tests.

RESULTS

Table 1. CAIT and AII – Significant differences detected between groups

	Control (n = 8)			CAI (n = 8)			
	Mean	SD	SEM (95% CI)	Mean	SD	SEM (95% CI)	p Value
CAIT - Left	30.0	0.0	0.0	25.5*	4.8	1.7	<0.001
CAIT - Right	30.0	0.0	0.0	19.9*	4.4	1.6	0.007
AII	9.0	0.0	0.0	4.1*	1.6	0.6	0.004
SOT Composite	83.8	3.7	1.3	79.1	5.0	1.8	0.127

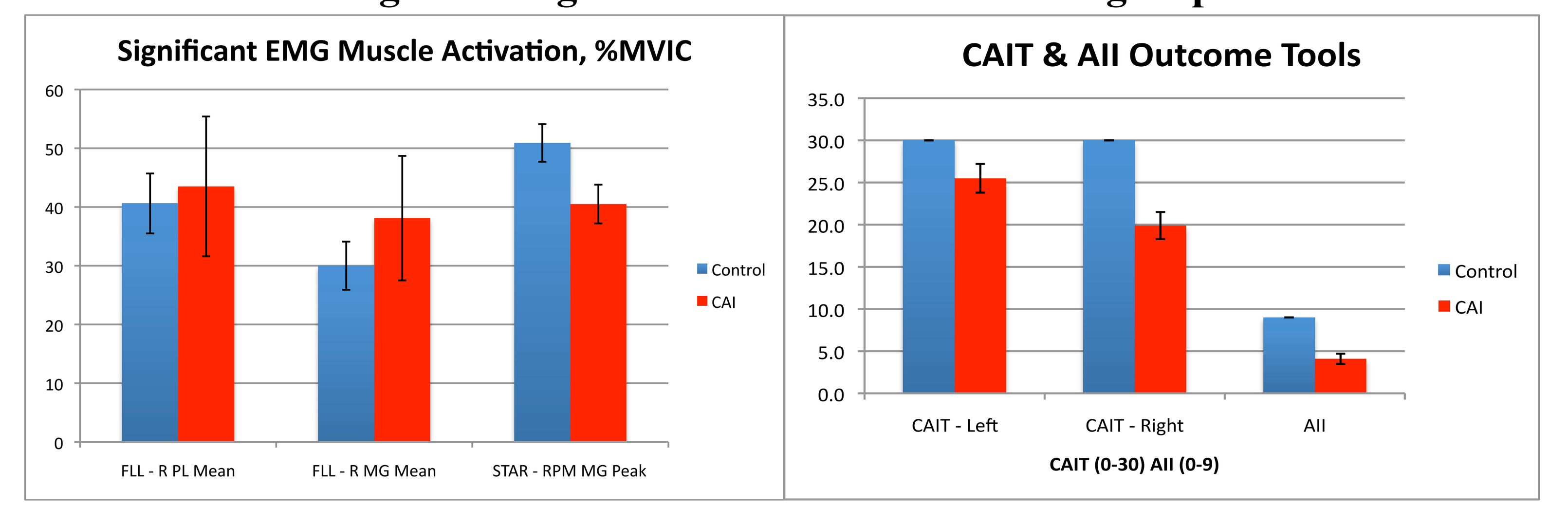
SEM, standard error of measurement. *, significant difference

Table 2. Significant differences observed during the Forward Lunge and SEBT

	Group	Mean	SD	SEM (95% CI)	p Value
FLL - R PL Mean	Control	40.6	14.4	5.1	0.029
	CAI	43.5	33.7	11.9	
FLL - R MG Mean	Control	30.0	11.7	4.1	<.001
	CAI	38.1	30.1	10.6	
STAR - RPM MG Peak	Control	50.9	9.1	3.2	0.042
	CAI	40.5	9.3	3.3	

SEM, standard error of measurement. FLL, Left forward lunge. PL, peroneus longus. MG, medial gastrocnemius.

Figure 2: Significant differences between groups



There were some significant correlations found between the outcome measures, CAIT and AII, and the forward lunge functional parameters of contact time and force impulse.

Table 4. Correlations

		FLL Contact Time	FLL Force Impulse	AII
CAIT	Pearson	-0.493	-0.498	0.897
	Sig. (2-tailed)	0.044	0.042	<0.01
AII	Pearson	-0.519	-0.53	
	Sig. (2-tailed)	0.039	0.035	

FLL, left forward lunge (R stance leg). Contact time, in sec. Force Impulse, %bodyweight x time (sec).

DISCUSSION/CONCLUSIONS

In the current study, significant differences were found between the control group and the CAI group for the CAIT and AII scores. Every participant in the CAI group scored well below the 27/30 that suggests chronic ankle instability on the CAIT, whereas every participant in the control group scored 30/30 suggesting no perceived functional instability. The AII suggests four or more yes answers as the threshold for CAI; all of the participants with CAI met this criterion as well.

Negative correlations were found between the CAIT scores and the Forward Lunge functional test, with contact time and force impulse. As the score on the CAIT decreased, indicating ankle instability, the time of contact of the lunging foot increased, suggesting that more time was required to stabilize the body at the end of the lunge and then return to the starting position.

The medial Gastrocnemius showed both significant differences as well as trends toward decreased activation in individuals with CAI. Suda and Sacco (2011) also observed differences in activation timing of the lateral Gastrocnemius and Peroneus Longus with a lateral stepping activity when comparing subjects in the control group to those with CAI. Fox and Docherty (2008) found significant eccentric plantar-flexor torque deficits in participants with CAI. Our findings with relation to the SEBT of decreased peak muscle activation parallel the findings of decreased peak torque production.

The clinical outcome measures, CAIT and AII, identified subjective measures of ankle instability, even when performance on functional tests did not show signs of instability in subjects with CAI. The deficits in the Gastrocnemius in the CAI group suggest that plantar flexors are also affected by ankle sprain injury. Clinically, the CAIT and AII can be used to asses for CAI and could possibly be used to track changes in patient function during rehabilitation. Also, the plantar flexors should be included in rehabilitation protocols and eccentric muscle activation should be facilitated. If these pilot findings are confirmed with follow-up studies, easily administered outcome measurement tools such as the CAIT and AII would simplify assessment of CAI and rehabilitation protocols can be focused to be more effective at limiting the impairments associated with CAI.

The results of this study suggest that there are some EMG muscular activation differences between subjects with CAI and normal controls in lower extremity musculature. In addition, the CAIT and AII were able to significantly distinguish between subjects with CAI and uninjured subjects in the control group.

References available on handout