Core Muscle Activation During Unstable Bicep Curl Using a Water-Filled Training Tube

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Abstract

PURPOSE: Stability and balance are essential components for functional movement. These components may developed by training with unstable surfaces, or unstable loads. The purpose of this study was to use a novel unstable implement ("slosh tube") and assess the degree of muscle instability created during a bicep curl. **METHODS**: Ten men (age= 21± 1.6y, ht=180.0 ± 3.3cm, mass= 87.4 ± 15.0kg) and ten women (age= 19.6± 1.3y, ht=161.4 ± 12.0cm, mass= 61.2 ± 7.4kg) completed three, 30s trials of a bicep curl using an 11.4 kg tube partially filled with water. A central valve allowed three conditions of water movement: 50% open valve, 100% open, and a balanced, closed (no flow) valve setting. Subjects completed 8 repetitions within each condition (1.5s per rep) using a counter-balanced design. Muscle activation was assessed on the right side, using bipolar surface electrodes placed over the belly of the bicep, deltoid, rectus abdominus and paraspinal muscles. Integrated EMG was measured for each repetition and converted to a %MVC for each muscle. Instability was determined using the natural log of coefficient of variation across repetitions. A two way repeated measures ANOVA (gender, condition) with post hoc t-tests (Bonferoni) was used to examine concentric(CON) and eccentric (ECC) contractions. **RESULTS**: There were no differences between gender for any condition in muscle instability. Significant instability was seen across treatments for paraspinal muscles for CON and ECC at 50% (CONLnCV= 3.13± 0.56, ECC CV=3.34 ± 0.58) and 100% (CON=3.24 ± 0.34, ECC= 3.46 ± 0.35) condition compared to stable (CON=2.59 ± 0.47, ECC= 2.80 ± 0.61). The deltoid showed greatest instability at the 100% open setting (CONCV= 3.51 ± 0.53,ECC=3.56 ± 0.36) compared to stable (CON= 2.98 ± 0.35,ECC=2.97 ± 0.45). The abdominal showed instability for the CON 100% condition only (LnCV= 3.02 ± 0.47) compared to stable (2.65 ± 0.43). There were no differences in bicep activation in any condition. These data show that the tube was effective in creating an unstable load that required instantaneous and continual activation of core and joint support muscles, effectively dampening the instability so that the bicep muscle could lift the load with minimal perturbation. **CONCLUSION**: We conclude that a bicep curl using an unstable implement utilizing water inertia causes increased paraspinal ,deltoid and abdominal muscle instability in men and women, while attenuating the instability of the prime mover.

Introduction and Background

Functional training (Instability Resistance Training or IRT) targets core musculature in addition to primary mover muscles, and the goal of IRT is to engage core musculature to maintain balance and posture throughout the exercise movement. Shimada et al. (2003) concluded that balance differs in static and dynamic exercises, suggesting that Behm and Anderson (2006) are correct in stating that IRT will increase neuromuscular activity through balance instability. Therefore greater neuromuscular activity will activate the core muscles and enhance neurological activity in the brain as well as increasing overall muscle activation throughout an exercise motion. Thus far, instability training has only analyzed one type of instability generation, which is usually generated by the ground surface or by free standing loads (dumbbells). For example, some IRT training is done on a BOSU ball or a Swiss ball, whereas in the current study the instability is generated by the device being lifted. Having the device generate the instability factor, now a once static bicep curl will be a dynamic exercise. Research performed by Colado et al. (2011) found that dynamic movements incorporate core (abdominal and paraspinal) musculature in comparison to static movements which stimulated the core very minimally, if at all. Lehman et al. (2006) performed a research study that examined a standard push-up on a stable surface and an unstable surface. It was found that the primary mover muscles were unchanged by the change in stability during the exercise. However, secondary mover muscles and core stabilizing muscles were greatly affected by the change in stability. While performing the push up on the Swiss ball (unstable surface) more musculature was activated in the shoulders and abdominals, showing that greater muscle activity is generated while performing an exercise on an unstable surface.

These findings can be extrapolated to strength and conditioning as well as rehabilitative purposes. Behm et al. (2012) found that IRT is a beneficial form of rehabilitation, which was concluded in the review of literature Behm conducted analyzing a great deal of IRT research. Behm and his team found that IRT increases joint stability, joint integrity and stabilizer muscles increased with IRT as well as core musculature. These increases have the potential to decrease low back pain and injury, as well as decrease the likelihood of joint related injuries such as sprained ankles, knee injuries etc. IRT is a great training regimen not only for sport specific movements but also those recovering from injury, special populations and general fitness. Research to date has examined the muscle activation while training on unstable surfaces. However no research is available regarding muscle activation while lifting a unique, unstable implement that has its own internal instability. Since the movement required to lift a load may involve the entire body, lifting an unstable implement may activate a wider range of stabilizing muscles.

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Purpose

The purpose of this study was to assess muscle instability during a bicep curl at three different flow settings using a novel, water filled training tube.

Methods

Day 1: Orientation , Practice and 1RM

- Height, weight, Resting BP, HHQ
- Informed Consent
- Bicep 1RM assessed using barbells
- Practice with device at all settings, at prescribed pace (20 reps/min)

Day 2: Experimental Treatment

Bipolar, surface electrodes placed on the participants right side, and on the following muscles: bicep, anterior deltoid, abdominal and paraspinal muscles (placement according to Cram), Ground electrodes were placed on boney prominences. Skin impedance was less than 2 KΩ

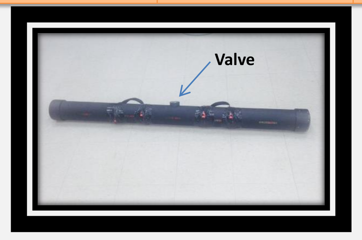
- **Bicep**- mid belly of the bicep, parallel to fiber orientation
- **Anterior Deltoid**- mid belly, parallel to fiber orientation
- **Abdominal**- 2 cm lateral from navel, palpate abdominal wall. Vertical orientation
- **Paraspinal**- Level of 12th rib and posterior spinal column, electrode on muscle belly, 2 cm laterally from the spine. Vertical orientation

Table 1 Subject Characteristics

Gender	Number	Age (y)	Height (cm)	Mass(kg)	Resting SBP (mmHg)	Resting DBP (mmHg)	1 RM (kg)
Male	10	21.0 ± 0.6*	180.0 ± 3.3*	87.0 ± 15.4*	129.3 ± 9.1	75.4 ± 6.6	54.1 ± 8.0*
Female	10	19.6 ± 1.3	161.4 ± 12.0	61.2 ± 7.4	120.3 ± 10.4	74.5 ± 6.5	27.0 ± 4.3

*** Denotes significant gender difference (P<.05)**

Instability Test Procedure

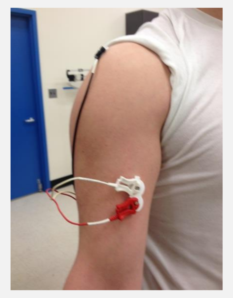


Instability Valve settings:

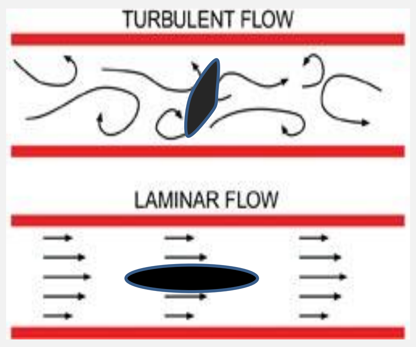
- "**Stable**"- mid valve closed, water equally distributed
- **50% open**- Valve open at 45 deg., water can move back and forth, creating turbulence
- **100% open**- valve completely open, allows laminar flow across tube.

- Participants were in an athletic stance, feet shoulder width apart with their knees slightly bent. At the pace of a metronome (tempo: 20 lifts/min)
  - 8-10 repetitions across a 30s sample period.
  - concentric-eccentric contraction transition marked manually
  - Subjects were assigned a test order (stable, 50%, 100%) using a counterbalanced design.
- Between each set the participant was given a 2-5 minute rest period.
- Following bicep curl trials a Maximal Voluntary Contraction was recorded for each muscle analyzed.

Raw data were collected (Biopac. 1000Hz) and filtered (high pass Blackman-67Db, 30hz cutoff, 255 coefficients). Data were then rectified and integrated, with each EMG burst being standardized to a specific sample size and normalized to participant MVC.

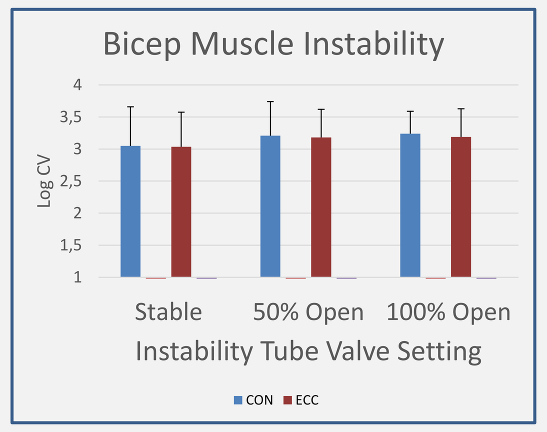


This research protocol has been approved by the Human Research Review Committee at Grand Valley State University. File No. 14-054-H

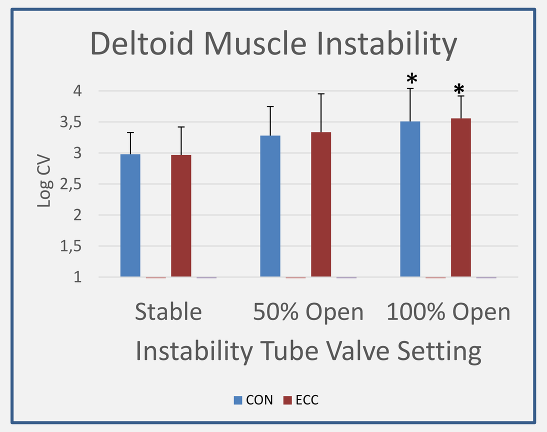


Water flow at 50% and 100% open

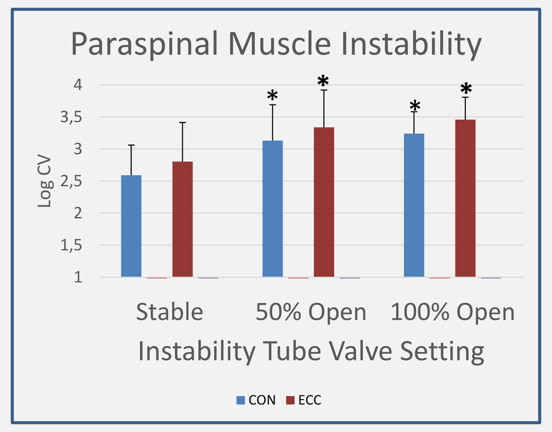
Instability Across Muscles



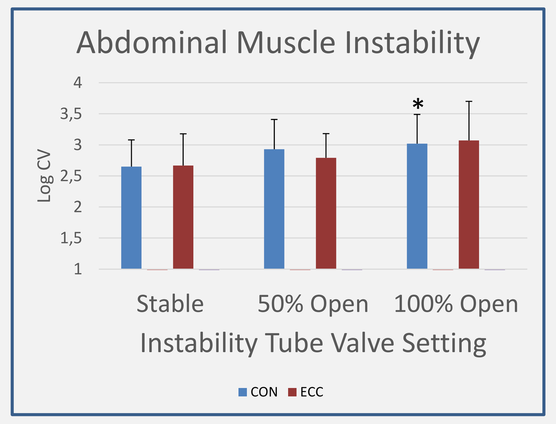
No significant differences



* = CON & ECC 100% > CON & ECC Stable



* = CON & ECC 50% and 100% > Stable



* = CON 100% > Stable

Figure 1

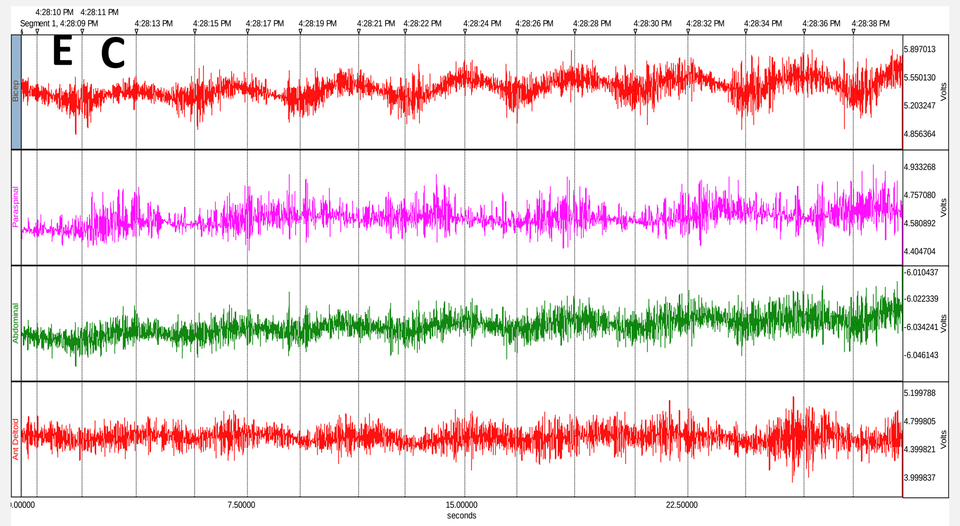


Figure 1. represents raw data of the associated muscles; (from top to bottom) Bicep, Paraspinal, Abdominals and Anterior Deltoid. **C** represent Concentric (shortening) contraction; **E** represents eccentric (lengthening) contractions during the bicep curl. Dashed vertical lines separate each contraction cycle.

Figure 2

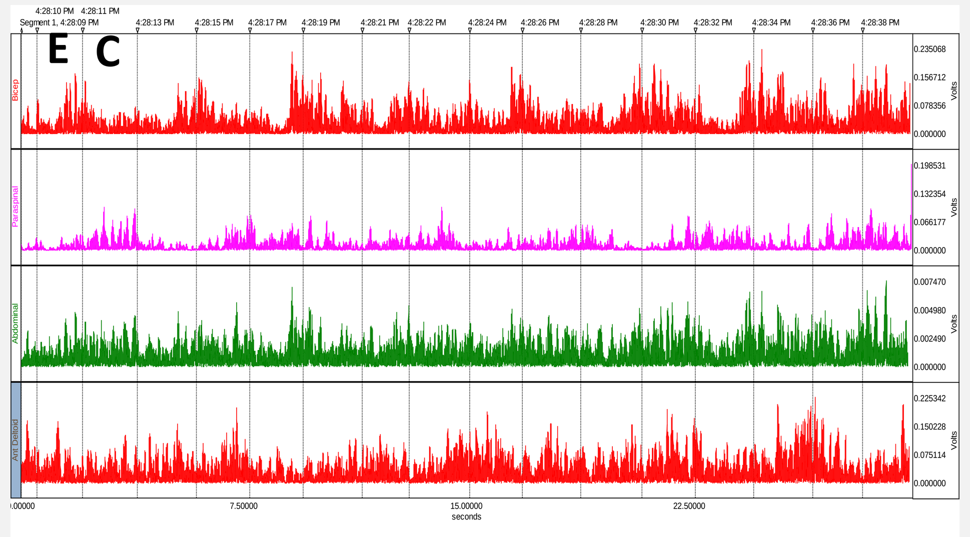


Figure 2 represents rectified data of the associated muscles; (from top to bottom) Bicep, Paraspinal, Abdominals and Anterior Deltoid. **C** represent Concentric (shortening) contraction; **E** represents eccentric (lengthening) contractions during the bicep curl. Dashed vertical lines separate each contraction cycle.

Statistics: Identifying variability

- % MVC for each contraction averaged across each trial
- Coefficient of Variation calculated for each muscle, each trial
- Due to skewed variances, Natural Log of CV computed
- 2 way, repeated measures ANOVA (gender x condition)
- Each muscle tested separate for Ln(CV), each contraction type (CON,ECC)
- Post Hoc t-tests (Bonferoni adjusted) when significant main effects identified

Discussion

The data show that performing a bicep curl using the unstable, water filled tube elicits a significant increase in muscle activation instability in core muscles (abdominal, paraspinal) as well as a joint stabilizer (deltoid) with no changes in bicep muscle instability. The valve settings of 50% and 100 open flow create water movement that requires these muscles to continually adjust to the perturbations, and serve to dampen the instability, allowing the bicep muscle to primarily perform the curl with little instability. Previous research has primarily focused on examining the effects of an unstable base of support on muscle activation. This study focused on using an unstable implement, and examining the degree of instability rather than a magnitude of activation comparison. Functional training is designed to provide real-time perturbations to the body, requiring instantaneous adjustments on core muscles and joint support muscles. The data from the present study indicate that variability in muscle activation is greatest in the paraspinal muscles during both the 50% and 100% valve open settings. The nature of the water flow differences between 50% and 100% flow may account for the significant instability in the deltoid only seem at 100% valve open, as this setting allows water to move more rapidly back and forth, causing greater two dimensional (frontal plane) instability, while the 50% valve setting allow less frontal but more transverse plane movement, creating instability in 3 dimensions. We conclude that this water-filled training tube provide an effective instability training stimulus for core and joint support musculature.

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