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Comparison of Electromyographic Activity When Performing an Inverted Row With and Without a Suspension Device

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ABSTRACT

Snarr RL, Esco MR. Comparison of Electromyographic Activity When Performing an Inverted Row With and Without a Suspension Device. **JEPonline** 2013;16(6):51-58. This study determined the extent of electromyographic (EMG) activity of the latissimus dorsi (LD), middle trapezius (MT), posterior deltoid (PD), and biceps brachii (BB) while performing the inverted row (IR) with and without a suspension training (ST) device. Eleven men and 4 women participated in this study. Each subject performed 4 repetitions of the IR with and without a ST device while EMG activity was recorded for each of the studied musculature. There were no significant differences in EMG activity of the LD, MT, and PD between each exercise ($P>0.05$). However, EMG activity of the BB was significantly greater ($P<0.05$) with the IR compared to the suspension inverted row (SIR). The results of this study demonstrated no significant differences in the selected musculature of the posterior chain (i.e., LD, MT, and PD) between the IR and the SIR. Therefore, it appears that the ST device provided a suitable alternative to traditional equipment (e.g., a Smith machine) when targeting the posterior musculature analyzed in this study with the IR. However, BB activity was significantly lower when performing the IR with the ST device compared to the traditional approach.

Key Words: Suspension Training, EMG, Inverted Row, Exercise

INTRODUCTION

Suspension training (ST) is a new mode of stability training that employs the use of two independent, freely moving handles suspended by two straps with a fixed anchor position above the exerciser (e.g., pull-up bar, smith machine, ceiling). The manufactures of ST devices claim that it provides a greater muscular demand when performing typical bodyweight exercises. The unstable nature of the device may elicit an increase in muscular activation while performing a particular exercise (1,7,8). However, very limited investigations exist that have examined the effects of this form of training. For instance, two studies have shown an increase in muscular output of selected shoulder girdle and abdominal musculature when performing push-ups with ST compared to the traditional approach (1,7). Though the sparse research suggests ST may be effective for pushing-type upper-body movements, there are no studies to date examining its effects on pulling movements.

The inverted row (IR) is a bodyweight exercise designed to target the musculature of the posterior chain, such as the latissimus dorsi (LD), middle trapezius (MT), and posterior deltoid (PD) (3,5). The IR is typically performed using a standard fixed-position barbell on a squat rack or smith machine with the exerciser in a supine position directly beneath the bar with the feet on the floor and hands placed on the bar with a pronated grip. The body is pulled toward the bar in a rowing manner by activating the posterior upper torso musculature and the elbow flexors (e.g., biceps brachii [BB]). The IR can be a useful exercise when seeking a balance between pushing and pulling movements in a resistance training program, which is essential in preventing injuries (10). Furthermore, the IR serves as a beginning progression of the bodyweight pull-up exercise and can be initially performed by individuals attempting to increase overall back strength.

There are no studies to determine the effects of ST on selected musculature during the IR. Therefore, the purpose of this study was to determine the extent of electromyographic (EMG) activity of the LD, MT, PD, and BB while performing the IR with and without a ST device. It was hypothesized that the ST device would elicit greater activation of the studied superficial musculature.

METHODS

Subjects

All subjects were recruited through flyers and word of mouth. Fifteen subjects (11 males and 4 females) volunteered to participate in this investigation. Descriptive statistics for the subjects are shown in Table 1. All subjects completed an informed consent and a health history questionnaire that indicated they were free from cardiorespiratory, musculoskeletal, and neurological disorders. This investigation was approved by the University's Institutional Review Board.

Table 1. Descriptive Data of the Subjects.

Conditions	Males	Females	All
Age (yrs)	26.6 ± 4.2	22.3 ± 1.0	25.4 ± 4.1
Height (cm)	178.8 ± 8.6	173.8 ± 5.7	177.5 ± 8.1
Weight (kg)	82.0 ± 8.0	68.0 ± 7.57	78.3 ± 9.9
BMI	25.7 ± 2.1	22.5 ± 2.0	24.8 ± 2.5

BMI: Body Mass Index; Values reported as Means ± SD

Procedures

Electromyography

All EMG values were captured using a Biopac MP150 BioNomadix Wireless Physiology Monitoring system at a sampling rate of 1,000 Hz and analyzed using Acqknowledge 4.2 software (BIOPAC System, Inc., Goleta, CA). BiopacEL504 disposable Ag-AgCl surface electrodes were applied to each subject. Skin sites for electrode placement were prepared with shaving, exfoliating, and alcohol cleansing to clear the area of dead surface tissue and oils that may reduce impedance. Electrode sites were chosen according to Cram and Kasman and placed on the right side of the body (2).

Electrodes for the latissimus dorsi were placed approximately 4 cm beneath the inferior angle of the scapula, half the distance between the lateral border of the torso and the spine, spaced 2 cm apart and at an oblique angle (i.e., 25°) following direction of the muscle fibers. Posterior deltoid electrodes were placed 2 cm below the lateral border of the spine of the scapula, spaced 2 cm apart and angled toward the deltoid tuberosity. Middle trapezius electrodes were placed 2 cm apart and parallel to the muscle fibers between the thoracic vertebrae and the medial border of the spine of the scapula. Electrodes for the biceps brachii were placed vertically 2 cm apart directly over the muscle belly on the anterior aspect of the arm. A ground electrode was placed over the anterior superior iliac spine (ASIS).

Exercise Trials

All data collection occurred during one session for each subject during which four different exercises (i.e., IR, SIR) were performed along with maximum voluntary contractions (MVCs) for each muscle group examined. Post-electrode placement MVCs were used to normalize all EMG data signals. All MVC procedures are consistent with those described by Konrad (4).

- ***Latissimus Dorsi*:** Obtained through isometric replication of a lat pull-down with arms placed in a lateral or frontal position at 90° of flexion.

- ***Posterior Deltoid:*** MVCs were obtained through a secured back, seated position with arms fully extended and angled slightly in front of the subjects. A matched resistance was then applied as the subject attempted to extend the arm at the glenohumeral joint.

- ***Middle-Trapezius*:** The subject assumed a prone position on an athletic table with the right arm hanging down to the side of the table. A matched resistance was then applied as the subject attempted to horizontally abduct the arm.

- ***Biceps Brachii*:** The subject assumed a kneeling position with the upper arm placed on a bench at 90°. A matched resistance was then applied as the subjects attempted to flex the elbow.

Once the data were normalized with MVCs, the subjects practiced proper technique of each exercise to be performed. Exercises were randomized between each subject to prevent fatigue error in the data. All exercise techniques were taught by a Certified Strength and Conditioning Specialist (NSCA-CSCS). In order for the exercises to be completed, a suspension device (TRX® Suspension Trainer®) was attached overhead to a smith machine. Each subject was allowed a 3-min rest between each trial to avoid fatigue. The exercise techniques used for this study are as follows:

- ***Inverted Row With and Without a Suspension Device:*** In order to perform the IR and SIR, a Smith machine bar and suspension handles were both set at approximately hip height for each

subject. Then, each subject assumed the following starting position: a supine bridge directly below the bar (or handles) with the arms fully extended and hands pronated and grasping the bar (or handles). The spine was to be kept rigid to create a plank-like posture with knees bent to 90°. The feet were placed flat on the floor. Each subject then began the exercise by pulling the body upwards towards the bar or handles until the chest reached the level of the hands. To complete the repetition, the body was lowered slowly back to the starting position.

Statistical Analyses

Data analysis was performed using SPSS/PASW Statistics version 18.0 (Somers, NY). Means and standard deviations were calculated for each variable (LD, PD, MT, and BB). Paired samples *t*-tests were used to determine if the raw (mV) and normalized (%MVC) values for the LD, MT, PD, and BB were significantly different across the two exercises. A priori statistical significance was set to a value of $P \leq 0.05$.

RESULTS

All subjects completed each exercise trial successfully, and all data were included in the analysis process. Mean (±SD) raw values of the selected musculature across each exercise are shown in Table 2. There were no significant differences in raw EMG of the LD, MT, and PD between each exercise ($P>0.05$, Table 2). However, EMG activity of the BB was significantly greater with IR compared to SIR ($P<0.05$, Table 2).

Table 2. Comparison of the Raw (mV) and Normalized (%MVC) EMG Values of the Selected Musculature Between the IR versus SIR.

	Raw EMG values (mV)		Normalized EMG values (%)	
	IR	SIR	IR	SIR
LD	3.74 ± 2.15	3.91 ± 2.34	99.3 ± 53.3	101.6 ± 46.5
MT	3.06 ± 1.89	2.85 ± 1.55	98.6 ± 35.6	98.4 ± 54.2
PD	3.41 ± 1.39	3.55 ± 1.61	98.6 ± 26.8	103.4 ± 35.7
BB	4.48 ± 1.44	3.95 ± 1.28*	76.7 ± 19.1	67.9 ± 20.1*

Values are reported as Means ± SD. **LD** = latissimus dorsi, **MT** = middle trapezius, **PD** = posterior deltoid, **BB** = biceps brachii, **IR** = inverted row, **SIR** = suspension inverted row. *Significantly lower compared to IR ($P<0.05$).

Mean (±SD) normalized values (%MVC) of the examined musculature between both exercises are shown in Table 2. Although normalized EMG activity of the BB was significantly greater during the IR compared to SIR ($P>0.05$, Table 2, Figures 1 and 2), the posterior chain musculature (i.e., LD, MT, and PD) demonstrated no significant differences between each exercise ($P>0.05$, Table 2).

DISCUSSION

The purpose of this study was to determine the extent of electromyographic (EMG) activity of the LD, MT, PD, and BB while performing the IR with and without an ST device. The results of this investigation are inconsistent with the hypothesis that the suspension device would elicit a greater activation of the superficial primary movers during the IR performed with a suspension device.

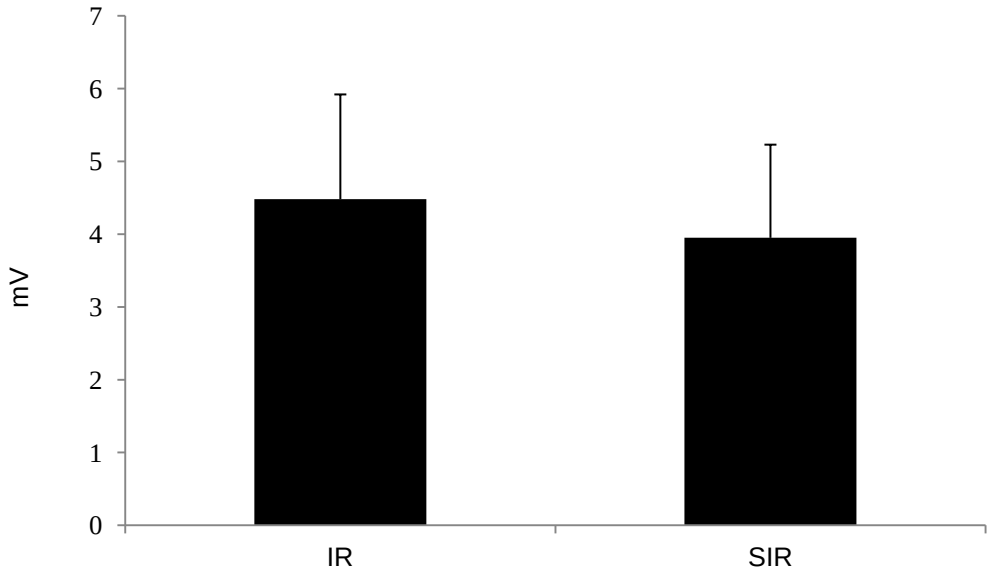

Figure 1. Comparison of Raw Electromyographic Activity (mV) of the Biceps Brachii Across Two Exercise Trials: Inverted Row (IR); and Suspended Inverted Row (SIR). *The SIR was significantly lower than the IR (P<0.05).

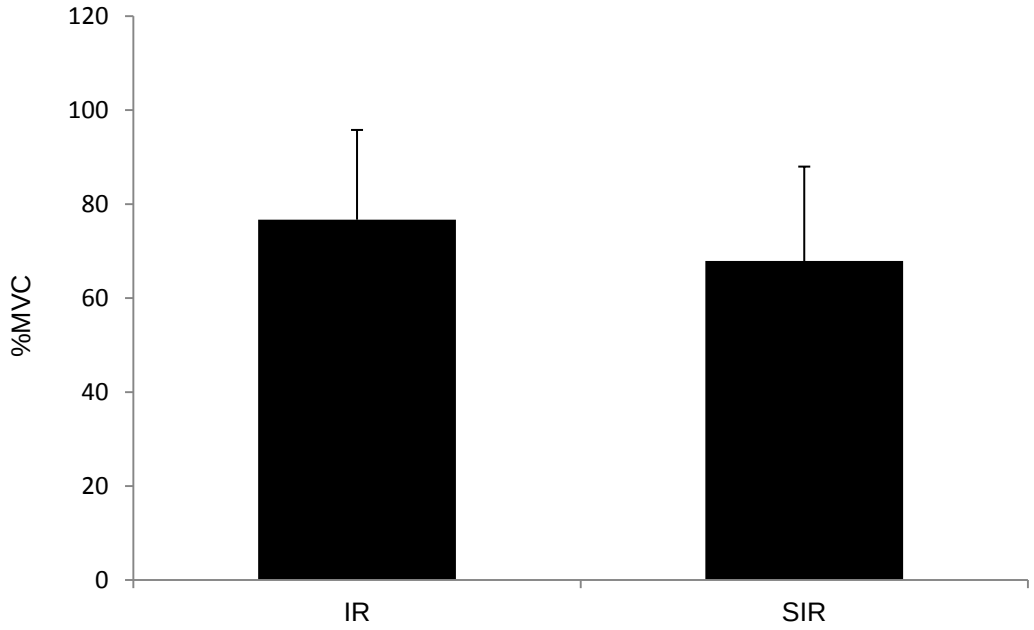

Figure 2. Comparison of Normalized Electromyographic Activity (%MVC) of the Biceps Brachii Across Two Exercise Trials: Inverted Row (IR); and Suspended Inverted Row (SIR). *The SIR was significantly lower than the IR (P<0.05).

There were no significant differences in the selected musculature of the posterior chain (i.e., LD, MT, and PD) between IR and SIR. Therefore, it appears that the IR performed with a ST device is just as effective as when performed with traditional equipment (e.g., a Smith machine) when targeting the posterior musculature analyzed in this study. However, BB activity was significantly lower when performing the IR with the ST device compared to the traditional approach.

This is the first study of its kind and hence it is difficult to compare the results with previous research. Most studies have shown that muscular activation of anterior upper torso muscular is higher when performing body weight-based pushing movements with ST compared to without (1,7,8). For example, Snarr et al. (8) found a significant increase in pectoralis major and rectus abdominis activation during a suspension push-up as compared to its traditional counterpart. Beach et al. (1) also exhibited a significant increase in abdominal wall and latissimus dorsi activity while performing suspension push-ups. However, the current findings found either the same (i.e., LD, MT, and PD) or lower (i.e., BB) levels of muscular activation when the IR was performed with a suspension device compared with a stable bar. There are several theoretical explanations of the findings.

Suspension devices were created as a method to challenge stability. However, during the IR the exerciser lies in a supine position suspended from either a fixed barbell or an ST device while the body acts as the opposing resistance. This position perhaps offers no challenge to stability. Thus, the primary movers serve one role as agonists. The need for roles as stabilizers when pulling the body upwards to the bar (IR) or handles (SIR) may be the same. Therefore, a difference in muscular activation of posterior musculature (i.e., LD, MT, and AD) between the IR performed with or without an ST device would not be present. Second, the results of lower BB activity with SIR compared to IR could be due to a decrease in the range of elbow flexion with the SIR. Several studies have determined that hand-grip position (i.e., wide vs. narrow) during pulling movements (e.g., lat pull-down, pull-ups, and seated rows) have elicited similar EMG values in the BB (5,6). However, these studies all used a fixed bar position. Due to the freely moving handles of the ST device, the elbow may travel through a lower range of motion compared to when the handles are fixed.

Limitations of this Study

This study has three limitations that should be noted. First, only one version of the IR was performed during this investigation (e.g., knees placed at 90° with feet flat on the floor), which required a minimal load for each subject (i.e., slight percentage of body weight). Future research should examine an IR with increased loads (e.g., legs fully extended or feet placed on a bench), thereby increasing muscular demands. Second, the investigation included subjects who were familiar with ST as well as those who had no previous experience with instability training. Previous research by Wahl and Behm (9) indicated that an individual with a high resistance-training background may elicit lower EMG values during different forms of instability training. A future study may provide a deeper look into muscular activation between novice and advanced individuals in regards to ST. Third, the present study examined only one traditional pulling movement on the suspension device (i.e., the IR). Different exercises (e.g., suspension pull-up vs. traditional pull-ups) that incorporate the posterior chain musculature should be examined to determine ST effectiveness during these types of movements. Fourth, this study did not measure the EMG activity of the abdominal wall. Suspension training is a form of instability training that is intended to increase perturbations within the trunk musculature. Therefore, it is important that future research determines the EMG activation of the abdominal wall (e.g., rectus abdominis, erector spinae, and external obliques) while performing exercises on the ST device.

CONCLUSIONS

The results of this study suggest that there are similar levels of EMG activity in superficial posterior musculature of the upper body (i.e., LD, MT, and PD) between performing an inverted row with and without a suspension training device. However, the inverted row on the suspension device elicited a lower BB activity compared to the traditional method. Further research is needed on this newer form of stability training.

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