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Effects of hand-grip during the inverted row with and without a suspension device: An electromyographical investigation

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ABSTRACT

While suspension devices have gained in popularity in the fitness industry, there is limited information on the effects of hand-grip orientations during pulling movements as compared to traditional methods. Objective: To investigate the electromyographical activity of the primary and secondary musculature during a pronated and supinated grip inverted row while using a suspension training device. Twenty individuals volunteered to participate in the current study. Electromyographical (EMG) values were obtained from the latissimus dorsi (LD), posterior deltoid (PD), middle trapezius (MT), and biceps brachii (BB). Subjects performed four variations of a traditional inverted row using two hand-grips: pronated row (IR), pronated suspended-row (SR), supinated row (IRsup), and supinated suspended-row (SRsup). In terms of the LD, SR provided the highest activation. However the only difference was within IRsup, which was significantly lower than both pronated-grip rows (i.e., IR and SR). SRsup resulted in significantly greater ($p < 0.05$) activation of the BB when compared to the remaining exercises. SR provided significantly greater ($p < 0.05$) PD activity, while EMG activity of the MT was significantly lower in SRsup compared to all other movements. The results indicate that significant differences exist in muscular activity during hand-grip variations as well as with the use of an instability device. The major findings were the decreases seen in PD and MT when using a supinated grip. As a result, suspension devices may provide an acute suitable alternative to traditional bodyweight training.

Key Findings

- *Significant differences exist between pronated and supinated grip inverted rows.*
- *Suspension devices show increases in bicep and posterior deltoid activity compared to traditional methods.*
- *Posterior deltoid and middle trapezius activity are significantly reduced during supinated grip inverted rows.*

Key Words: Suspension training, EMG, resistance training, TRX, instability

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INTRODUCTION

The inverted row is a traditional bodyweight exercise designed to target the upper back and rear shoulder musculature.[1, 2] The major benefit of the inverted row is that it places decreased spinal loading on the lower back as compared to other pulling exercises (i.e., bent-over row and 1-arm cable row); while still providing sufficient muscular activation of the latissimus dorsi and upper erector spinae group.[1] A reduction in spinal compression is essential when prescribing exercise for individuals whom should avoid spinal compression and perturbations. The exercise may also be important within a well designed exercise program that equally focuses on opposing musculature that may decrease shoulder complex injuries and increase sports performance.[3,4,5]

Suspension training is a recent approach that incorporates stability and balance training into traditional conditioning and rehabilitation programming. This method of training is desirable because it is portable, relatively inexpensive, and allows the exerciser to use their bodyweight as resistance. The proposed benefits of instability training is increased neuromuscular activation compared to stable resistance training methods, along with increases in cross-sectional area and improvements in neuromuscular coordination.[6] Previous literature has demonstrated an increased activation of primary and abdominal wall musculature during suspension training exercises (i.e., pushups)[7,8,9]; however, there is limited information on the effects of this instability device while using different hand grip orientations as compared to traditional stable methods.

While hand grip orientations have been studied during the lat pull-down and pull-up [4,5,10,11], the authors of the current study are unaware of any publications examining the inverted row in regards to varying grips along with changes in instability. Thus, the purpose of the current study was to examine the electromyographical activity of the primary and secondary musculature (i.e., latissimus dorsi, biceps brachii, posterior deltoid, and middle trapezius) during a pronated and supinated grip inverted row while using a suspension training device.

MATERIALS AND METHODS

METHODS

Participants

Twenty apparently-healthy individuals (12 men and 8 women; age = 26.6 ± 4.2 years; height = 177.5 ± 8.1 cm; weight = 78.3 ± 9.9 kg) volunteered to participate in the current study. All subjects were recruited via word-of-mouth and through flyers. Participants were pre-screened to exclude individuals with any cardiorespiratory, metabolic, neurological, or musculoskeletal disorders.

Procedures

Electromyographical values were obtained using a BIOPAC MP150 BioNomadix Wireless monitoring system at a sampling rate of 1.0 kHz. EMG data was analyzed using Acqknowledge 4.2 software (BIOPAC System, Inc., Goleta, CA). Electrodes used for the current investigation were disposable Ag-AgCl (Biopac EL 504) surface electrodes. Prior to application, all skin sites were prepped to reduce impedance. All electrodes were placed 2 cm apart and directly following the muscle fibers. A ground electrode was placed over the anterior superior iliac spine.

Electrode placement was as follows: [12]

- Latissimus dorsi (LD): Approximately 4 cm beneath the inferior angle of the scapula at an oblique angle (i.e., 25°), half the distance between the lateral border of the spine and torso.
- Posterior deltoid (PD): Placed 2 cm below the lateral border of the spine of the scapula and angled toward the deltoid tuberosity.
- Middle trapezius (MT): Adhered parallel to the muscle fibers between the thoracic vertebrae and the medial border of the spine of the scapula. Electrodes for the
- Biceps brachii (BB): Placed vertically, directly over the muscle belly, on the anterior aspect of the arm.

Exercise Trials

Participants made one visit to the Human Performance Laboratory for the data collection process. Four exercises were performed along with maximum voluntary contractions (MVC's) while EMG values were obtained from each muscular group. MVC procedures are consistent with Konrad and were performed to normalize all EMG values during testing.[13]

Participants were given time to familiarize themselves with all testing procedures prior to participation. Exercise order was randomized to prevent fatigue error within the data. All repetitions were performed at a rate of 4-seconds (2-second concentric, 2-second eccentric) and measured by a metronome. The following techniques were used to perform each exercise:

- Pronated Grip Inverted Row With and Without a Suspension Device: Both exercises were performed in a similar fashion; however, a Smith Machine was utilized for the traditional stable method while a suspension device was used for the unstable method. The stable bar and suspension device were set at a level of hip height for each participant. Subjects began with a closed, pronated grip that was slightly wider than shoulder-width apart. Participants were then instructed to keep the spine and hips neutral (plank) with the feet placed on the ground and knees bent to 90^o. Once in the starting position, subjects began by pulling the torso towards the bar (or handles) until the chest reached the height of the hands.
- Supinated grip Inverted Row With and Without a Suspension Device: These two variations were performed as above; however, participants were instructed to use a supinated grip instead.

Statistical Analysis

All data analysis was completed using SPSS/PASW Statistics version 18.0 (Somers, NY). Means and standard deviations (SD) were calculated for each muscular group (BB, LD, MT, and PD). A repeated measures analysis of variance (ANOVA) was used to determine if raw (mV) and normalized (%MVC) values for BB, LD, MT, and PD were significantly different between the four exercises performed. A priori statistical significance was set to a value of $p < 0.05$. Magnitudes of the differences between the suspension device and traditional method were determined via Cohen's d procedure.[14]

RESULTS

The means (±SD) for the selected muscle groups for each exercise are provided in Table 1 (raw) and Table 2 (%MVC).

Latissimus Dorsi

Results indicate that SR provided the highest activation level of the LD in both raw and %MVC values. However, the only statistical difference was IRsup, which was significantly lower ($p < 0.05$) than IR and SR (%MVC).

Biceps Brachii

BB activity was significantly greater ($p < 0.05$; %MVC) during the SRsup compared to the remaining exercises. The pronated, suspension inverted row (SR) provided the lowest BB activation and was significantly less ($p < 0.05$) compared to the remaining movements.

Posterior Deltoid

Posterior deltoid activation was greatest during the SR, which was significantly greater ($p < 0.05$) than IR, IRsup, and SRsup. Results also indicated that both supinated grip movements (IRsup and SRsup) were significantly less ($p < 0.05$) than IR and SR.

Middle Trapezius

The traditional inverted row (IR) provided the highest activation of MT (raw and %MVC). Although, the only statistically significant difference ($p < 0.05$) was MT activity during the SRsup, which provided the lowest value compared to the three remaining exercises.

Table 1 Comparison of the raw EMG values (mV) of the selected musculature between the different exercises.

	LD	BB	PD	MT
IR	4.16 ± 2.32	4.54 ± 1.55	3.69 ± 1.57	2.79 ± 1.69
SR	4.40 ± 2.58	3.84 ± 1.36†	3.89 ± 1.80	2.63 ± 1.38
IRsup	3.68 ± 1.77*	4.44 ± 1.37‡	3.22 ± 1.28ˈ	2.26 ± 1.19
SRsup	4.22 ± 2.28	4.85 ± 1.48	3.12 ± 1.46ˈ	1.79 ± 0.74ʃ

LD = Latissimus Dorsi, BB = biceps brachii, PD = posterior deltoid, MT = middle trapezius, IR = inverted row (pronated grip), SR = suspended inverted row (pronated grip), IRsup = inverted row supinated grip, SRsup = suspended inverted row supinated grip
**Significantly lower compared to SR and SRsup (p < 0.05).; †Significantly lower compared to IR, IRsup, and SRsup (p < 0.05).*
‡Significantly lower compared to SRsup (p < 0.05).; ˈSignificantly lower compared to IR and SR (p < 0.05).
ʃSignificantly lower compared to IR, SR, and IRsup (p < 0.05).

Table 2 Comparison of the normalized EMG values (%MVC) of the selected musculature between the different exercises.

	LD	BB	PD	MT
IR	106.16 ± 59.78	75.49 ± 18.89‡	101.53 ± 29.36*	92.67 ± 32.83
SR	108.79 ± 52.91	64.31 ± 20.60†	107.70 ± 37.89	92.26 ± 47.22
IRsup	97.69 ± 52.81ˈ	76.12 ± 21.86‡	89.43 ± 30.21ˈ	78.72 ± 32.65
SRsup	104.67 ± 37.80	82.14 ± 22.32	84.38 ± 24.90ˈ	63.62 ± 24.29ʃ

LD = Latissimus Dorsi, BB = biceps brachii, PD = posterior deltoid, MT = middle trapezius, IR = inverted row (pronated grip), SR = suspended inverted row (pronated grip), IRsup = inverted row supinated grip, SRsup = suspended inverted row supinated grip
**Significantly lower compared to SR (p < 0.05). ; †Significantly lower compared to IR, IRsup, and SRsup (p < 0.05).*
‡Significantly lower compared to SRsup (p < 0.05).; ˈSignificantly lower compared to IR and SR (p < 0.05).
ʃSignificantly lower compared to IR, SR, and IRsup (p < 0.05).

DISCUSSION

While other pulling exercises (e.g., lat pull-down, bent-over row, etc.) have been extensively studied [1,5,10,11], limited information in regards to the IR is available. Therefore, the purpose of this investigation was two-fold: 1.) to measure the effectiveness of a suspension device during the IR as compared to the traditional method, and 2.) to determine the differences in the EMG activity during a pronated versus supinated hand-grip during the IR. Results indicate differences in muscular activity during hand grip variations as well as with the use of an instability device. Latissimus dorsi activity was fairly consistent across the handgrip variations, except for IRsup which resulted in a significantly lower activation of the LD than the remaining three movements. EMG activity in the BB was also affected by the change in handgrip, with the highest activity occurring in the supinated grip variation of the suspension inverted row (i.e., SRsup); while both pronated grips were significantly less than SRsup. Conversely, pronated grip rows for the PD were significantly greater than the supinated grip rows. Furthermore, SR provided a greater activation in the PD than the traditional IR. In terms of the MT, IR and SR provided similar levels of EMG activity, but were reduced in both of the supinated grip variations.

The current findings are different from previous investigations. For example, Lusk et al. found that pronated grip pull-downs activate the LD to greater extent than a supinated grip.[10] However, there were no differences in activation of the MT or BB in regards to grip changes, which is in disagreement with the current results.[10] Signorile et al. found significant differences in the LD using a pronated grip, but reported no differences in PD activity between various pronated and supinated lat pull-downs.[11]

The major findings of this study are the decreases seen in PD and MT when using a supinated grip. MT is responsible for retraction of the scapula; while the PD abducts, extends, and horizontally abducts the glenohumeral (GH) joint.[15] Switching to a supinated grip allows the shoulder joint to execute the concentric and eccentric portions of the movement in the sagittal plane (i.e., flexion/extension) instead of the transverse plane (i.e., horizontal abduction and adduction). When this occurs, the exercise involves limited scapula retraction, thereby decreasing activation of the MT. Although the PD extends the humerus, placing the shoulder joint in the frontal plane and extending at the GH joint may elicit greater activity of the triceps brachii (not measured within the current study) to complete the exercise. Decreases in PD activity may also be explained by the increases in BB activity during the supinated grip variations; whereas participants may have relied more on flexion of the humero-ulnar joint instead of a focus on GH extension.

Significant increases in elbow joint range of motion have been previously reported with a shift from a pronated to supinated pull-up. [5] Therefore, this increased range of motion may explain our results of significantly higher BB activity in SRsup. Although not studied within the current investigation, performing the supinated grip may also use less range of motion at the GH joint as compared to a pronated grip; thus, reducing the amount of LD and PD activation as seen by the changes in grip orientations. Previous investigations have explained these decreases in LD activity due to the decreases in distance of the shoulder joint to the bar during supinated pulling movements.[2,10,11] Furthermore, by changing the joint angle from horizontal and diagonal abduction during the IR and SR to GH extension, other superficial musculature increased (i.e., BB) in the current study indicating a shift in primary muscle activation required to complete the movement.

Another key discovery is the appearance of at least one significant difference between stable and suspended inverted rows within the examined musculature. For instance, SRsup provided significantly higher BB activity compared to all other exercises, but SR provided the lowest. Interestingly, there was no difference in EMG activity of the BB between the IR and IRsup. These results lead the authors to assume that design of suspension device itself may affect EMG activation during subtle changes. For example, during the IR and IRsup, the hands are in a fixed position allowing no rotation; whereas the suspension handles are freely moving and may have allowed for minor rotations during the pull. Other factors which may have affected recruitment patterns while using the suspension device include the ability to draw the arms in closer to the body (adduction) or the possibility for a greater range of motion by allowing the body to move past the level of the hands at the top of the pull; whereas a fixed bar would limit this motion.

CONCLUSION

Rehabilitation and fitness specialists often determine proper exercise prescription to reduce spinal compression and loading in individuals with lower back injuries or recurring pain. The inverted row has been previously demonstrated to reduce the spinal compression forces, while also provided significant muscular activation of the upper back musculature.[1] The findings of the current study indicate that changes in muscle activation during rowing movements can be affected by alterations in handgrip; thereby allowing the individual to focus on certain muscle groups (e.g., lats during a pronated grip inverted row or biceps during the supinated grip). Based upon %MVC values alone, suspension devices may provide an acute suitable alternative to traditional bodyweight training. However, future longitudinal research is warranted to determine the prolonged effects of suspension training.

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