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ORIGINAL ARTICLE

Strength performance parameters when adopting different exercise sequences during agonist–antagonist paired sets

Marianna de Freitas Maia, Gabriel Andrade Paz, João Souza, Humberto Miranda*

Federal University of Rio de Janeiro, School of Physical Education and Sports, RJ, Brazil

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KEYWORDS
Resistance training;
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Abstract
Objective: To investigate the effect of different exercise sequences during agonist–antagonist paired sets on training volume, ratings of perceived exertion, and muscle activation.
Material and methods: Thirteen recreationally trained males participated in this study. Two protocols were adopted in two non-consecutive days. BS – participants performed three repetition to failure sets (with 8 repetition maximum loads) of bench-press (BP) followed by seated row exercise in alternate manner. SB – the seated row (SR) was performed before bench press. Two-minute rest interval was adopted between sets and exercises. The number of repetitions and electromyography signals of the posterior deltoids (PD), biceps brachii (BB), pectoralis major (PM), and triceps brachii (TB) muscles were recorded during both exercises.
Results: No significant differences were noted in training volume (1486.6 ± 200.3; 1492 ± 282.5) and total work (22.3 ± 1.3; 22 ± 2) BS and SB sequences for BP, respectively. Higher training volume (1709.7 ± 177.6; 1424.4 ± 196) and total work (25.3 ± 1.8; 21 ± 1.6) were noted for SR under BS compared to SB. Higher PD activation was noted during SR under BS compared to SB.
Conclusion: The exercise sequence showed significant differences in strength performance and agonist muscle activation during agonist–antagonist paired sets for SR exercise. These results suggest that antagonist pre-loading may have a potential effect on back muscles.

* Corresponding author.
E-mail address: humbertomirandaufrj@gmail.com (H. Miranda).

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PALABRAS CLAVE
Entrenamiento de fuerza;
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Electromiografía

Parámetros de rendimiento de fuerza mediante la adopción de diferentes secuencias de ejercicios durante series emparejadas agonista-antagonista

Resumen
Objetivo: Investigar el efecto de distintas secuencias de ejercicios de series emparejadas de los músculos agonistas/antagonistas sobre el volumen del entrenamiento, la percepción subjetiva del esfuerzo y la activación muscular.
Material y método: Trece deportistas de recreación, hombres, fueron voluntariamente sometidos a este estudio. Se aplicaron 2 protocolos en 2 días no consecutivos. Protocolo BR: los participantes realizaron 3 series de ejercicios de press de banca (PB) hasta el agotamiento (con carga de 8 repeticiones máximas) seguidas del ejercicio de remo sentado (RS), alternadamente. Protocolo RB: el remo sentado se realizó antes del PB. Se adoptó un intervalo de recuperación de 2 min. Entre repeticiones y ejercicios. Durante los 2 ejercicios se anotaron el número de repeticiones y la señal electromiográfica de los músculos deltoides posterior (DP), del bíceps braquial (BB), del pectoral mayor (PM) y del tríceps braquial (TB).
Resultado: No se encontraron diferencias significativas en el volumen de entrenamiento (1.486,6 $\pm$ 200,3; 1.492 $\pm$ 282,5) y del trabajo total (22,3 $\pm$ 1,3; 22 $\pm$ 2) entre las secuencias BR y RB, para PB, respectivamente. Se observó un volumen de entrenamiento (1.709,7 $\pm$ 177,6; 1.424,4 $\pm$ 196) y del trabajo total (25,3 $\pm$ 1,8; 21 $\pm$ 1,6) superiores en el RS en la secuencia BR, comparado con RB.
Conclusión: La secuencia del ejercicio mostró diferencias significativas en el rendimiento de fuerza y activación muscular de los agonistas durante las series emparejadas agonista-antagonista en el ejercicio de RS. Estos resultados indican que la precarga de los antagonistas puede generar un efecto potencial para favorecer el rendimiento de los músculos dorsales.

Introduction

Resistance training has been widely used as an effective method for developing strength, endurance and/or power performance for athletes or general population.[1] The manipulation of intensity and volume of training are essential to increase the outcomes during resistance training programs.[2–4] Training volume (sets $\times$ repetitions $\times$ external load) is usually calculated by coaches and athletes during the resistance training sessions in order to increase the strength gains in acute and/or chronic manner.[5]

Several training systems are often applied in order to manipulate the training volume. One of these training systems is the agonist-antagonist paired set (PS), which can be accomplished in a shorter time (efficiency) without compromising efficacy (training volume).[6] PS training is characterized by performing exercises for agonist and antagonist muscles in alternated manner, with or without rest intervals between sets and exercises.[7] Previous evidences have been suggested that PS training allows a similar or higher strength performance than traditional set (TS) training, with a significant reduction in the duration of training session.[6,8,9]

Robbins et al.[7], observed similar training volume between TS (with 4-minute rest interval between sets and exercises) and PS (with 2-minute rest interval) training for bench pull and bench press exercises, with four repetition maximum (RM) loads. However, Robbins et al.[7], noted a higher efficiency (training volume/time) under PS, compared to TS considering training session duration. Recently, Maia et al.[9] found significant increases on repetition performance and electromyographic (EMG) data of vastus medialis and rectus femoris during leg extension followed by lying leg curl exercise (with 10RM loads), compared to a set of leg extension exercise performed without antagonist preloading. Similar results were noted by Paz et al.[10], who noted higher repetition performance and muscle activation of latissimus dorsi and biceps brachii for seated row exercise (10RM loads) immediately after a of bench press, when compared to set of seated row without antagonist preloading. Considering the effect of exercise order during APS, Balsamo et al.[8], observed higher training volume and lower ratings of perceived exertion (RPE) under PS session with leg curl followed by leg extension resistance exercise (with 10RM loads), compared to leg extension performed before leg curl exercise. These data suggest that the exercise order during PS training may promote significant interference on strength performance.

Several studies have shown that exercise order promote significant impact on repetition performance in acute manner during resistance training programs.[3,4,11] However, the effect of exercise order during PS training on muscles activation and strength performance are still unclear. These evidences may be useful resistance training practitioners and coaches who want to improve the strength outcomes and also reduce the training session duration. Therefore, the purpose of this study was to investigate the effect of PS training compared to TS on training volume, RPE and muscle