Revista Motricidad Humana
Mot. Hum. 2016;17 Supl 1:46-50

Meeting Abstract

Physiological responses related to training with partial blood flow restriction on an unstable surface

Respuestas fisiológicas relacionadas al entrenamiento con restricción parcial del flujo sanguíneo sobre superficie inestable

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Introduction

Several studies have reported that strength training with low intensity (20-30% of one repetition-maximum 1RM) combined with partial blood flow restriction to the muscle (PBFR) can produce muscular adaptations equivalent to high training. Evidence points to the effectiveness of this type of training regarding strength, hypertrophy and muscular endurance (1) with a shorter duration of training time. However, the responsible mechanisms for its effects are not yet fully clear. Metabolic stress plays the dominant role in the hypertrophic effects observed with the PBFR training, but mechanical stress also participates.

Both act synergistically to mediate a number of secondary mechanisms, which stimulate autocrine and/or paracrine actions for inducing muscle hypertrophy (2). Acute responses from the standpoint of metabolic stress of PBFR point to a muscle anabolism dependent acidity, causing an increase in blood lactate (3,4) and/or plasma concentrations (5,6), promoting a pH change, allowing growth hormone (GH) being stimulated by this intramuscular acidic environment (7) besides direct and indirect effects of lactate concentration in testosterone synthesis (8).

Regarding to training on unstable surfaces, the main effects related to the neuromuscular action are associated with increased activation of the muscles of the trunk (core) and limbs, as well as the agonist-antagonist co-contraction and static and dynamic balance, with significant use in the rehabilitation and prevention of injuries in non-athletes. There also have been observed similar responses during unstable and stable conditions, for instance in the case of the squat, core

muscles activation of the muscles of the trunk and limbs is greater in the first condition (9), as well as during bench press more energy expenditure and metabolic impact is achieved (10). Nevertheless, adding resistance exercise to the unstable base may reduce force production, speed and range of motion (11, 12).

The aim of this research was to compare half-squat exercise on an unstable surface, with and without PBFR, half squat with overload at 70%RM and half squat with PBFR with overload at 30%RM on the acute response of heart rate (HR), lactate concentration (lactate) and ratings of perceived exertion (OMNI-RPE), for the same volume of repetitions.

Methodology

Sample was composed by volunteers, healthy students, previously signing an informed consent. Health condition was assessed by clinical anamnesis, BMI and blood pressure control. Individuals with high blood pressure, smokers and with skeletal muscle injuries in lower limbs were excluded; being selected only 7 from a total of 12 candidates.

Each of the subjects was applied a maximal strength squat test (1RM) using Smith press in order to establish workloads during exercise sessions. Participants performed protocols with a separation of 72-96 hours, though the same sequence order was not the same during protocols, in order to avoid bias in results. These protocols were organized as follows:

- HIST (high intensity stable training): Half squat on a stable surface with load at 70%RM, performed in a Smith press doing traditionally.
- SPBFR (stable training with partial blood flow restriction): Half squat on a stable surface with load at 30%RM with PBFR, performed in a Smith press.
- UNS (unstable training without blood flow restriction): Half squat on a stable surface (without BFR) performed on tires disks.
- UNS+PBFR (unstable training + partial blood flow restriction): Half squat on a unstable surface with PBFR, on tires disks.

During the execution of these protocols, carefully attention was put so that they have the same training parameters during repetitions, for a total of 45 repetitions over 3 sets of 15 repetitions each one, with 1 min rest between sets and working rate of 2" concentric and 2" of eccentric contractions. PBFR protocols applied pressure of 180 mmHg restriction. Pre and post HR intervention lactate and OMNI-RPE was registered. The statistical analysis considered record values (mean ± SD) at both points of time to determine the normality of the sample, using Shapiro-Will test. In addition to compare changes between groups ANOVA and Bonferroni post hoc tests were applied. In each case $p<0.05$ was considered.

Results

Table 1 shows general characteristics of the sample. Table 2 shows physiological responses of the HR, lactate and OMNI-RPE produced in the different training protocols, indicating variables that show significant differences.

Table 1. General characteristics of the sample (Mean±SD).

Age	Weight	Height	BMI	HR rest	SBP	DBP
22.3±1.4	72.8±9.1	174.7±5.2	23.8±2.3	76.1±16.0	120.3±2.4	79.7±8.0

BMI (kg/m2): body mass index, HR rest (lpm): resting heart rate, SBP (mmHg): systolic blood pressure; and DBP (mmHg) diastolic blood pressure.

Table 2. Physiological responses of HR, lactate and OMNI-RPE (mean±SD) obtained during different training protocols.

Variable	Training Type	Pre	Post	*p*	Significant between training type
HR (lpm)	HIST	90.9±11.8	160.7±21.9	0.001	HIST vs UNS
	SPBFR	93.3±10.5	147.1±15.4	0.005	HIST vs UNS+PBFR
	UNS	90.7±14.1	121.4±12.3	0.044	SPBFR vs UNS
	UNS+PBFR	90.7±15.6	127.3±14.4		
Lactate (mmol/lt)	HIST	2.4±0.6	9.8±2.6	0.008	HIST vs SBFR
	SPBFR	2.7±0.4	6.9±0.6	0.000	HIST vs UNS
	UNS	2.8±0.8	4.0±1.3	0.000	HIST vs UNS+PBFR
	UNS+PBFR	2.4±0.5	4.5±0.8	0.009	SPBFR vs UNS
				0.038	SPBFR vs UNS+PBFR
OMNI-RPE (N°)	HIST	0.4±0.5	8.6±1.9		
	SPBFR	0.4±0.5	6.0±1.3	0.006	HIST vs UNS
	UNS	0.4±0.5	5.1±1.8	0.039	HIST vs UNS+PBFR
	UNS+PBFR	0.4±0.5	5.9±1.8		

Discussion

Of the four types of exercises, there is a greater physiological stress in half squat on a stable surface with load at 70%RM (HIST) and half squat on a stable surface with 30%RM (SBFR) in terms HR - lactate - OMNI-RPE. These data are coincident, for HR and OMNI-RPE exercising with elastic bandages applying PBFR. It has also been observed more subjective perception of effort measured by OMNI-RPE in the same exercise, with the same volume and load applied with or without PBFR(13). High HR during PBFR exercise, despite low load, is attributable to a

reduced venous return (4) and autonomous cardiac monitoring (14), which together with a muscle acidosis linked to production of lactate-hydrogenions (H+) might increase metabolic stress, which plays a key role in the hypertrophic effects of training with PBFR (2). This metabolic condition has been observed in different protocols using PBFR, even having a similar behavior in exercises with small muscles (biceps and gastrocnemius), where PBFR protocol vs traditional training have similar behavior in lactate concentration, with increased GH response in the first, but without changes in other hormones such as testosterone, free testosterone and cortisol, leading to the conclusion that volume and intensity of protocols, with and without PBFR, were not enough to bring about changes in these hormonal parameters (15).

In our study, the muscle action or exercise volume selected for the "unstable" condition, could not achieve comparable changes with stable traditional exercise HIST or SBFR exercise. However, PBFR application on unstable surfaces generates greater metabolic stress that unstable exercise without PBFR, similar situation to the one observed during an unstable exercise circuit vs stable with or without PBFR (16). This phenomenon could be a useful tool conforming to the purposes being pursued with unstable exercise (co-activation, balance or injury prevention). From the results further investigations are suggested with adjustments in the own training variables, such as performing series of exercises until muscular failure, applying different restrictive pressures or changing density of the stimulus, intervening during interset rests.

Conclusion

Resistance exercise on a stable surface with or without PBFR, generates a major change in the parameters of intensity recorded, compared to the two exercises on unstable surface; besides PBFR addiction to unstable physiological exercise generates greater intensity, which could enhance the effects on unstable training.

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Recibido: 22-06-2016 **Aceptado:** 04-07-2016