

THE INFLUENCE OF WHOLE BODY VIBRATION ON THE MECHANICAL BEHAVIOUR OF SKELETAL MUSCLE

Bosco C. 1,2,3, M. Cardinale, 4, R. Colli 5, J. Tihanyi 3, S.P. von Duvillard 6, A. Viru 7

1 University of Rome -Tor Vergata, Fondazione "Don Gnocchi", Rome, Italy 2 Department of Biology of Physical Activity, University of Jyväskylä, Finland 3 Department of Biomechanics, Hungarian University of Physical Education, Budapest, Hungary 4 Research and Study Center, Italian Handball Federation 5 Research and Study Center Italian Cycling Federation 6 Department of HPER, University of North Dakota, Grand Forks, USA 7 Institute of Exercise Biology, University of Tartu, Estonia

ABSTRACT

The aim of this study was to investigate the effects of whole body vibrations on the mechanical behaviour of human skeletal muscles. For this purpose, fourteen physically active subjects were recruited and randomly assigned to an experimental (EG) and a control group (CG). The EG was treated for ten days with 5 sets of vertical sinusoidal vibrations lasting up to two minutes each, for a total volume of ten minutes per day. The subjects of CG were asked to maintain their normal activity and avoid strength or jumping training. Subjects were tested at the beginning and at the end of the treatment with specific jumping tests performed on a resistive platform. Results showed remarkable and statistically significant enhancement in the EG of the height of the best jump (1.6 %, $P < 0.5$), the mechanical power of the best jump (3.3 %, $P < 0.5$) and the average jumping height during 5s Cj (12 %, $P < 0.01$). In contrast, no statistically significant variations were noted in the CG. Consequently, it was suggested that the effect of WBV treatment elicit fast biological adaptation connected to neural potentiation.

Biology in Sport 3 (15) 1998: 157 - 164

THE INFLUENCE OF WHOLE BODY VIBRATION ON THE MECHANICAL BEHAVIOUR OF SKELETAL MUSCLE

Bosco C. 1,2,3, M. Cardinale, 4, R. Colli 5, J. Tihanyi 3, S.P. von Duvillard 6, A. Viru 7

1 University of Rome -Tor Vergata, Fondazione "Don Gnocchi", Rome, Italy 2 Department of Biology of Physical Activity, University of Jyväskylä, Finland 3 Department of Biomechanics, Hungarian University of Physical Education, Budapest, Hungary 4 Research and Study Center, Italian Handball Federation 5 Research and Study Center Italian Cycling Federation 6 Department of HPER, University of North Dakota, Grand Forks, USA 7 Institute of Exercise Biol., University of Tartu, Estonia

ABSTRACT

The aim of this study was to investigate the effects of whole body vibrations on the mechanical behaviour of human skeletal muscles. For this purpose, fourteen physically active subjects were recruited and randomly assigned to an experimental (EG) and a control group (CG). The EG was treated for ten days with 5 sets of vertical sinusoidal vibrations lasting up to two minutes each, for a total volume of ten minutes per day. The subjects of CG were asked to maintain their normal activity and avoid strength or jumping training. Subjects were tested at the beginning and at the end of the treatment with specific jumping tests performed on a resistive platform. Results showed remarkable and statistically significant enhancement in the EG of the height of the best jump (1.6 %, $P < 0.5$), the mechanical power of the best jump (3.3 %, $P < 0.5$) and the average jumping height during 5s Cj (12 %, $P < 0.01$). In contrast, no statistically significant variations were noted in the CG. Consequently, it was suggested that the effect of WBV treatment elicit fast biological adaptation connected to neural potentiation.

Table 1. Mean values (x) ± standard deviation (SD) of the Average Power (AP), Average Velocity (AV) and Average Force (AF) measured during leg press performances executed with progressive extra-loads, before and immediately after WBV treatment, in the Experimental leg and in the Control leg.

EXPERIMENTAL LEG

Load (kg)		AP (W)		AV (m/s)		AF (m/s)	
		Before	After	Before	After	Before	After
70	X	319	340 **	0.434	0.462 *	735	737
	SD	21	11	0.025	0.015	6	5
90	X	352	375 ***	0.374	0.398 ***	936	941 *
	SD	11	4	0.011	0.003	8	9
110	X	359	389 ***	0.317	0.342 ***	1134	1138 *
	SD	25	21	0.018	0.015	14	15
139	X	354	373 ***	0.267	0.281 ***	1324	1327 *
	SD	42	42	0.028	0.027	20	19

CONTROL LEG

Load (kg)		AP (W)		AV (m/s)		AF (m/s)	
		Before	After	Before	After	Before	After
70	X	318	321	0.431	0.436	737	736
	SD	25	8	0.032	0.010	5	5
90	X	348	363	0.371	0.387	937	937
	SD	18	23	0.016	0.022	11	12
110	X	372	373	0.327	0.328	1136	1137
	SD	23	19	0.019	0.013	5	15
139	X	360	372	0.272	0.279*	1324	1328
	SD	44	37	0.03	0.025	14	17

Significant difference before and after treatment:

- * P<0.05
- ** P<0.01
- *** P<0.001

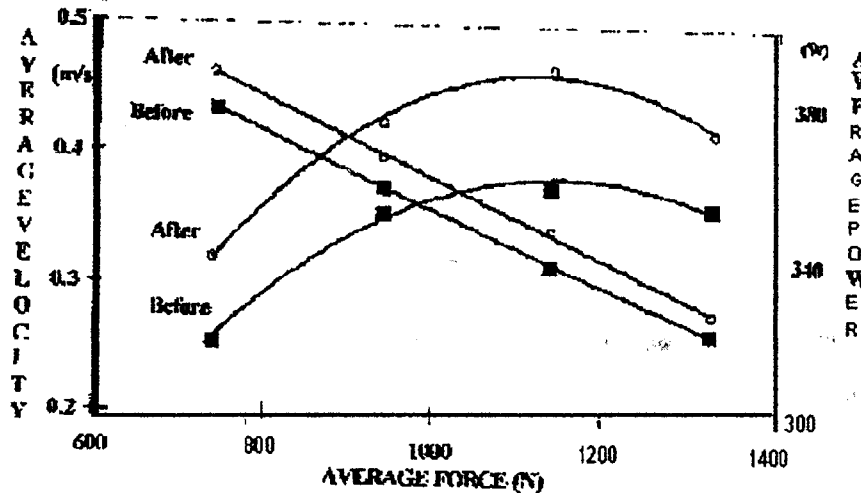
ADAPTIVE RESPONSES OF HUMAN SKELETAL MUSCLE TO VIBRATION EXPOSURE.

C. Bosco^{1,2,3}, R. Colli⁵, E. Intorini⁴, M. Cardinale⁴, M. Iacovelli¹, J. Tihanyi³, S.P. von Duvillard⁷, A. Viru⁸

¹University of Rome - Tor Vergata, Fondazione 'Don Gnocchi', Rome, Italy ²Department of Biology of Physical Activity, University of Jyväskylä, Finland ³Department of Biomechanics, Hungarian University of Physical Education, Budapest, Hungary ⁴Research and Study Center, Italian Handball Federation ⁵Research and Study Center Italian Cycling Federation ⁶University of Rome - La Sapienza, II Chair of Human Physiology, Italy ⁷Department of HPER, University of North Dakota, Grand Forks, USA ⁸Institute of Exercise Biology, University of Tartu, Estonia

ABSTRACT

The study was performed in order to test the possibility whether a single whole body vibration (WBV) session will produce human skeletal muscle response. In 6 female volleyball players movement velocity, muscle force and power were recorded when they performed maximal leg press exercises with extra load of 70, 90, 110 and 130 kg. The testing took place before and after a 10-min WBV exposure. During WBV subjects were in the standing position with the toes of one leg on the vibration platform (E leg) while the other leg (C leg) was risen from the ground. WBV induced statistically ($P < 0.05$) significant improvement of the movement velocity, muscle force and power. In result-, the velocity-force and power-force curve were shifted to the right. C leg failed to show changes in studied mechanical variables after the WBV session. In conclusion, the acute effect of a short term WBV on neuromuscular apparatus is expressed by improved movement velocity, muscle force and power in performing leg press exercise with external loads.



Influence of brief daily tendon vibration on rat soleus muscle in non-weight-bearing situation

Maurice Falempin and Soumeya Fodili In-Albon

Laboratoire de Plasticité Neuromusculaire, Université des Sciences et Technologies de Lille I, 59655 Villeneuve D'Ascq Cedex, France

ABSTRACT

The purpose of this study was to investigate whether tendon vibration could prevent soleus muscle atrophy during hindlimb unloading (HU). Mechanical vibrations with a constant low amplitude (0.3 mm) were applied (192 s/day) with constant frequency (120 Hz) to the Achilles tendon of the unloaded muscle during the 14-day HU period. Significant reductions in muscle mass (41%), fiber size, maximal twitch (54%), and tetanic tensions (73%) as well as changes in fiber type and electrophoretic profiles and twitch-time parameters (31% in the contraction time and 30% in the half relaxation time) were found after 14 days of HU when compared with the control soleus. Tendon vibration applied during HU significantly attenuated, but did not prevent, 1) the loss of muscle mass (17 vs. 41%); 2) the decrease in the fiber cross-sectional area of type IIA (28 vs. 50%) and type IIC (29 vs. 56%) fibers; and 3) the decrease in maximal twitch (3 vs. 54%) and maximal tetanic tensions (29 vs. 73%) and the half relaxation time (1 vs. 30%). Changes in the contraction time and in histological and electrophoretical parameters associated with HU were not counteracted. These findings suggest that tendon vibration can be used as a paradigm to counteract the atrophic process observed after HU.

hindlimb unloading; muscular atrophy; countermeasure

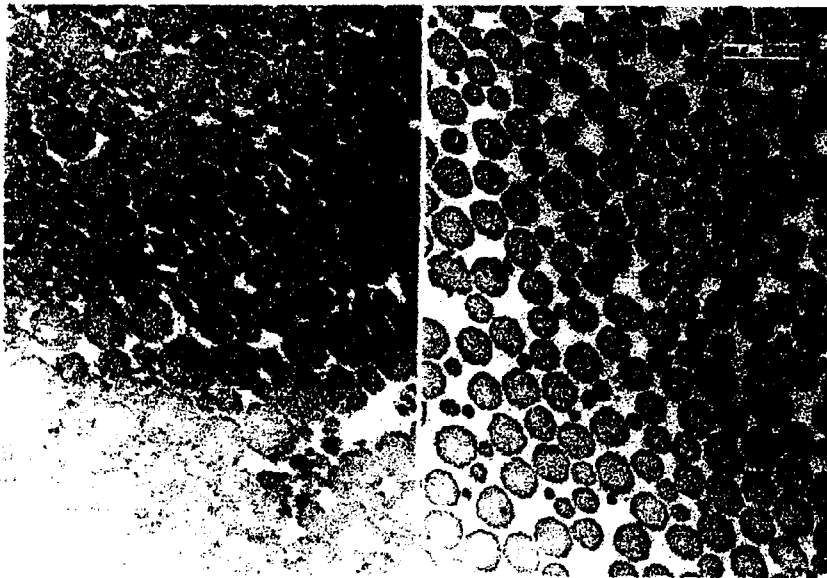


Fig. 4. Collagen fibres in transverse section in the rat soleus muscle tendon. Left: control. Right: disease. $\times 52,000$