Contents lists available at ScienceDirect

Cytokine

journal homepage: www.elsevier.com/locate/cytokine

Short communication

Hybrid training system-induced myokine secretion in healthy men

Ken-ichiro Sasaki^{a,*}, Yuta Ishizaki^a, Motoki Sasaki^a, Takaharu Nakayoshi^a, Masanori Ohtsuka^a, Hiroo Matsuse^b, Naoto Shiba^b, Takafumi Ueno^a, Yoshihiro Fukumoto^a

^a Division of Cardiovascular Medicine, Department of Internal Medicine, Kurume University School of Medicine, Kurume, Japan
^b Department of Rehabilitation, Kurume University Hospital, Kurume, Japan

ARTICLE INFO	A B S T R A C T
Keywords: Training Myokine Erythropoietin CTACK TRAIL	The hybrid training system (HTS) is a special and compact system for effective skeletal muscle training by a combined application of volitional and electrical muscle contraction. Lower limbs' muscle training using HTS has been reported to increase not only muscle strength but also plasma interleukin-6 levels; however, little is known in other cytokines. In this study, we measured 52 cytokines and creatine phosphokinase-MM in the serum of 16 healthy men before and after lower limbs' muscle training by the knee flexion and extension using HTS. Skeletal muscle volume-corrected serum concentrations of cutaneous T-cell-attracting chemokine, erythropoietin, and tumor necrosis factor-related apoptosis-inducing ligand increased immediately after the training. These increased cytokines have been reported to play important roles in wound healing, neuroprotection, and cardio-
	vascular protection.

1. Introduction

Neuromuscular electrical stimulation contracts skeletal muscles via percutaneous electrodes that depolarize underlying motor nerves. The electrical muscle contraction (EMC) increases muscle mass and strength, and improves muscle atrophy and weakness. Combined application of volitional muscle contraction (VMC) and EMC has been reported to increase muscle strength more than VMC or EMC alone [1]. The hybrid training system (HTS), which adds motion resistance to volitionally contracting agonist skeletal muscles by simultaneous contraction of the antagonist skeletal muscles with low-intensity electrical stimulation, is a special and compact system for effective skeletal muscle training by a combined application of VMC and EMC [2]. In lower limb muscle training by the knee flexion and extension, HTS has increased strength in concentric and eccentric torque by approximately 40%, which is comparable to a large training machine at approximately 70% of the maximum VMC [2].

Skeletal muscle produces a variety of "myokines", which act an autocrine, paracrine, or endocrine hormone. In a bicycle exercise training using HTS, serum IL-6 levels were increased immediately after the training [3]. Meanwhile, lower limbs' muscle training by the knee flexion and extension using HTS has reduced serum IL-6 levels at 3 months [4]. Thus, the changes in the serum concentration of IL-6 following skeletal muscle contraction using HTS seems to be

multilateral. However, little is known about the issues regarding other cytokines following HTS induced skeletal muscle contraction. Accordingly, we measured the serum concentrations of 52 cytokines in healthy men before and after lower limbs' muscle training by the knee flexion and extension using HTS.

2. Materials and methods

2.1. Subjects

Healthy volunteers who gave written informed consent participated in this study. This study conformed to the principles outlined in the Declaration of Helsinki and was approved by the Committees on the Ethics Review Board of the Kurume University School of Medicine.

2.2. Measurement of skeletal muscle volume

Skeletal muscle volume of lower limbs was measured just before the collection of blood sample with a bioelectrical impedance analyzer (InBody S10, Biospace, Tokyo, Japan).

2.3. VMC and EMC hybrid training experiments using HTS

Special Electrodes (NIHON MEDIX, Chiba, Japan) were placed over

https://doi.org/10.1016/j.cyto.2018.08.023







^{*} Corresponding author at: Division of Cardiovascular Medicine, Department of Internal Medicine, Kurume University School of Medicine, 67 Asahi-machi, Kurume 830-0011, Japan.

E-mail address: sasaken@med.kurume-u.ac.jp (K.-i. Sasaki).

Received 24 April 2018; Received in revised form 7 August 2018; Accepted 22 August 2018 1043-4666/ © 2018 Elsevier Ltd. All rights reserved.

Knee extension



Fig. 1. Schemata of the lower limb's muscle training by the knee extension and flexion using the hybrid training system. In the knee extension and flexion exercise, a controlled-electrical muscle contraction of the antagonist muscles is compounded into the volitional muscle contraction of the agonist muscles, inducing some degree of resistance to the volitional motion.

Volitional

motion

the motor points of the quadriceps and hamstrings of the subject sitting in a chair. The electrodes were connected to a special device of HTS [2–4]. Fig. 1 shows the mechanism of the composite application of VMC and EMC using HTS. The muscle training consisted of 10 sets of 10 reciprocal knee flexion and extension contractions with approximately 70% of 1 repetition maximum [2]. Twenty minutes were required for the training. The venous blood was immediately collected within 5 min before and after the muscle training, and the serum was stored at -80 °C.

2.4. Measurement of serum cytokines and creatine phosphokinase-MM

We measured the concentration of 51 kinds of serum cytokines all together with a magnetic bead-based multiplex assay kit (Bio-Plex Pro^{TM} Human Cytokine Standard Group I 27-Plex, Group II 21-Plex, and TGF- β 3-Plex, Bio-Rad Laboratories, CA, USA). The 51 cytokines were as follows: interleukin (IL)-1 β , IL-1 receptor α (IL-1 α), IL-2, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-12 (p70), IL-13, IL-15, IL-17, basic fibroblast growth factor (b-FGF), eotaxin, granulocyte colony-stimulating factor (G-CSF), granulocyte-macrophage colony-stimulating factor

(GM-CSF), interferon-y(IFN-y), interferon gamma-induced protein 10 (IP-10), monocyte chemoattractant protein-1 (MCP-1), macrophage inflammatory protein-1 α (MIP-1 α), MIP-1 β , platelet-derived growth factor-BB (PDGF-BB), regulated upon activation normal T-cell expressed and secreted (RANTES), tumor necrosis factor- α (TNF- α), and vascular endothelial growth factor (VEGF), cutaneous T-cell-attracting chemokine (CTACK), growth-regulated alpha (GRO-α), hepatocyte growth factor (HGF), IFN-a2, IL-1a, IL-2Ra, IL-3, IL-12 (p40), IL-16, IL-18, leukemia inhibitory factor (LIF), MCP-3, macrophage colony-stimulating factor (M-CSF), macrophage migration inhibitory factor (MIF), macrophage-induced gene (MIG), β-nerve growth factor (β-NGF), stem cell factor (SCF), stem cell growth factor-B (SCGF-B), stromal cell-derived factor- 1α (SDF- 1α), TNF- β , tumor necrosis factorrelated apoptosis-inducing ligand (TRAIL), transforming growth factorβ1 (TGF-β1), TGF-β2, and TGF-β3. In addition, we measured the concentration of erythropoietin (EPO) with an enzyme-linked immunosorbent assay kit (abcam, Boston, MA, USA). All assays were performed according to the manufacturer's instructions. Creatine phosphokinase-MM (CK-MM), which is an isozyme of creatine phosphokinase and mainly included in skeletal muscle cells, was measured by the JSCC transferable method.

2.5. Statistical analysis

Continuous variables are presented as the mean \pm SE. Normal distribution of measured variables was checked using the Shapiro-Wilk test. Statistical comparisons were performed using a paired *t*-test and Wilcoxon signed-rank test. Statistical significance was assumed at a value of p < 0.05. Data were analyzed using JMP Pro 11.0 (SAS Institute, Cary, NC, USA).

3. Results

Sixteen healthy men (36.4 \pm 1.1 years) participated in this study. Their body weight and height were 67.1 ± 1.8 Kg and 170.8 \pm 1.4 cm, respectively. Because the increased cytokines in the peripheral blood after the VMC and EMC hybrid training might be mainly derived from the skeletal muscles of the lower limbs (so-called myokines), measured concentrations of serum cytokines and CK-MM were individually corrected with corresponding skeletal muscle volume of bilateral lower limbs of each subject. First, we were not able to detect the serum concentrations of GROa, IL-1a, IL-1β, IL-3, IL-5, IL-6, IL-10, IL-12 (p40), IL-13, LIF, MCP-3, MIP-1α, and TNF-β in all participants. Further, some other cytokines, such as b-FGF, GM-CSF, IFN-a2, IL-1Ra, IL-2, IL-4, IL-12 (p70), IL-15, and VEGF, were not detected in some participants' serums. Finally, serum concentrations of CTACK, EPO, and TRAIL, but not IL-6, increased immediately after the VMC and EMC hybrid training (Table 1).

4. Discussion

In this small-group study, we have demonstrated first that CTACK, EPO, and TRAIL immediately increased in the serum after a 20-minute lower limbs' muscle training by the knee flexion and extension using HTS. These increased cytokines were possibly secreted from the skeletal muscles of the lower limbs as 'exercise-induced myokines'. Exercising leg-released EPO in peripheral blood has been actually reported in healthy men [5]. However we cannot contradict that they were actually secreted from other cells.

CTACK/CCL27 is an epithelial-expressed chemokine. Keratinocytes, which are epithelial cells of skin, express the chemokine for recruiting T-cells to cutaneous sites [6]. CTACK/CCL27 has regulated the migration of keratinocyte precursor cells from bone marrow into skin and accelerated skin regeneration in mice [7]. Mobilization of the keratinocyte precursor cells in the circulation may promote the healing of skin ulcers in patients with diabetes mellitus and ischemic peripheral

Download English Version:

https://daneshyari.com/en/article/9955296

Download Persian Version:

https://daneshyari.com/article/9955296

Daneshyari.com