SHORT REPORT

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Whole-Body Electromyostimulation – The Need for Common Sense! Rationale and Guideline for a Safe and Effective Training

Ganzkörper-Elektromyostimulation – eine Richtlinie zur sicheren und effektiven Anwendung

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Summary

› **Whole-body electromyostimulation (WB-EMS)** is a young and time-effective training technology. Comparing the effect of WB-EMS with conventional resistance training, both methods were reported to be similarly effective on muscle mass, strength and cardiometabolic risk. However, due to its exceptional time efficiency, joint friendliness and individualized setting, WB-EMS may be a good choice for people unable or simply unwilling to conduct intense resistance training protocols.

› **However,** recent literature has reported negative side-effects concerning WB-EMS-induced rhabdomyolysis. Indeed, due to the ability to innervate large muscle areas simultaneously with dedicated individual intensity per muscle group, WB-EMS features many factors known to be associated with muscle damage. A recent WB-EMS study applying an initial application to exhaustion to healthy novices confirmed the reported exceptionally high creatine-kinase (CK) concentrations. Although the study did not detect any of the reported clinical consequences of this "severe" rhabdomyolysis (i.e. ≥50fold increase of resting CK), in less fit subjects who were neither optimally prepared nor supervised, initial WB-EMS to exertion may have more far-reaching consequences.

› **Of importance,** a subsequent WB-EMS conditioning phase of 10 weeks completed by a second WB-EMS test application to exhaustion demonstrated CK-peaks in the range of conventional resistance exercise.

› **Thus, in summary** (a) too intense initial WB-EMS may indeed result in a severe rhabdomyolysis (b) thus, initial WB-EMS application to exhaustion must be strictly avoided, and (c) frequent WB-EMS application demonstrated a very pronounced repeated bout effect after a short conditioning phase.

Zusammenfassung

› **Ganzkörper-Elektromyostimulation (WB-EMS)** erfreut sich durch Zeiteffizienz, Individualisierbarkeit und Effektivität zunehmender Beliebtheit. In jüngster Vergangenheit wurden nach Erstanwendung von WB-EMS in Einzelfällen jedoch (extrem) hohe Kreatinkinase (CK)-Werte berichtet, die in einem gesundheitlich bedenklichen Bereich liegen. Bedingt durch die flächige simultane Applikation mit dezidierter Ansteuerung der Stimulationsflächen treffen für WB-EMS durchaus die meisten Voraussetzungen für eine „exertional Rhabdomyolysis", also eine ausgeprägte körpertrainings-induzierte Muskelschädigung zu.

› **Tatsächlich** zeigte eine kürzlich erschienene Untersuchung mit gesunden Sportlern ohne WB-EMS Vorerfahrung nach ausbelasteter, also hochintensiver, WB-EMS-Erstapplikation eine 117-fache Erhöhung der CK-Konzentrations-Werte im Bereich einer schweren („severe") Rhabdomyolyse (≥50-fache Erhöhung des Ruhe-CK). Obwohl für keinen der 26 Studienteilnehmer die in der Literatur berichten negativen renale und kardialen Indizien einer (schweren) Rhabdomyolyse vorlagen, mögen die Konsequenzen bei vorgeschädigten, leistungsschwachen und schlecht vorbereiteten Individuen deutlich dramatischer ausfallen.

› **Eine nachfolgende Untersuchung,** welche den Effekt regelmäßigen WB-EMS-Trainings evaluierte, zeigte nach 10-wöchigem Konditionierungszeitraum und anschließender, wiederum ausbelasteter, WB-EMS-Applikation einen ausgeprägten „repeated bout effect" mit CK-Spitzenwerten im unteren Bereich konventionellen Krafttrainings (<1000 IE/l), also in einem unbedenklichen Bereich.

› **Als Fazit** leiten wir ab, dass (a) unsachgemäße WB-EMS-Erstapplikation durchaus negative gesundheitliche Konsequenzen haben kann, (b) eine ausbelastende bzw. sehr intensive WB-EMS-Erstapplikation in jedem Fall zu unterbleiben hat und (c) ein rascher Gewöhnungseffekt auch hinsichtlich ausbelasteter WB-EMS-Applikation auftritt. Letzteres ist zur Realisierung relevanter Effekte, vergleichbar einem konventionellen Krafttraining, nicht zwingend nötig.

KEY WORDS:
Electrostimulation, Creatine-Kinase, Rhabdomyolysis, Recommendation WB-EMS

SCHLÜSSELWÖRTER:
Elektrostimulation, Kreatinkinase, Rhabdomyolyse, WB-EMS-Applikation

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Introduction

Whole-body electromyostimulation (WB-EMS) is a young and time effective training technology that focuses primarily on body composition (i.e. muscle, bone, fat tissue) and strength-related parameters (5, 7, 9, 13, 14). However, other health related outcomes (i.e. cardio-metabolic risk factors) (4) were also reported to be positively affected by WB-EMS. A direct comparison of WB-EMS and the slightly more time-consuming High Intensity (Resistance) Training (HIT) (WB-EMS: 1.5x20 vs. HIT: 2x30 min/week)

Guideline for Safe and Effective WB-EMS

In General

1. Safe and effective Whole-Body-EMS Training must be advised and accompanied by a trained and licensed WB-EMS trainer or scientifically trained personnel familiar with this field of application.
2. Before the first training session of every beginner, an anamnesis of possible contraindications based on a list of questions must be taken and then documented in writing, confirmed by the client's signature and archived. Where relevant anomalies are found, a doctor is to be consulted and training only be commenced if clearance has been given.

Preparing for Training

1. As with any kind of intensive training, Whole-Body EMS training must only be carried out in a good physical condition and free of pain. This includes abstaining from alcohol, drugs, stimulants/muscle relaxants or stress ahead of the training session. Training must never be carried out by anybody suffering from an illness with fever.
2. Whole-Body-EMS training leads to very high metabolic stress of the organism because of very high volume of muscle mass addressed. This factor has to be taken into account through sufficient food intake that is as high in carbohydrates as possible. If this is not possible, then at least a high carbohydrate, but light snack (≈250kcal) should be eaten, ideally about 2 hours before training.
3. So as to avoid possible renal stress (especially with undiagnosed problems) through intensive WB-EMS, additional fluids should be consumed before/during and after training (500ml each).
4. Generally, medical – ideally sport-medicinal – consultation and clarification is advisable in the case of any discomfort, physical restrictions, infections or other internal, cardiological or orthopedic illnesses.

Training

1. Regardless of physical status, sport experience and the user's wishes to that effect, under no circumstances may WB-EMS training to exhaustion take place during the first training session or trial training. In the past, this has led to undesired side effects and negative health consequences and must be avoided at all costs.
2. After moderate initial WB-EMS, the stimulation level or current must be successively increased and adapted to the individual goals. The highest level is to be reached only after 8-10 weeks of systematic training at the earliest (user's subjective effort impression: hard-hard+). Training to complete exhaustion, especially in the sense of painful, continuous tetanus during the current phase, must generally be avoided.
3. In addition, the initial training should be conducted with a reduced effective training period. Advisable is 5min impulse familiarization and a curtailed training session with moderate stimulus intensity (user's subjective effort impression: a bit hard) and 12min intermittent load with short impulse phase (~4s). Only then should the training duration be cautiously increased and never exceed 20min.
4. To ensure sufficient conditioning and to minimize or rule out possible health impairments, training frequency may not exceed one training unit per week during the first 8-10 weeks.
5. Even after this conditioning phase, an interval of ≥4 days must be maintained between training units in order to avoid accumulation of muscle breakdown products, permit regeneration and adaptation and thus ensure a successful training outcome.

Safety Aspects During and After Training

1. During the training session, the trainer or the trained and qualified personnel should concentrate exclusively on the interests of the user(s). Before, during and after training the trainer verbally and visually checks the user's condition so as to rule out health risks and ensure effective training. Training is to be stopped immediately if there are any contraindications.
2. During training, the equipment's operating controls must be directly in reach of the trainer and the user at all times. Operation/adjustment must be simple, quick and precise.
3. Actually, we generally advise against private use of technology without support of a qualified and licensed trainer/instructor or correspondingly scientifically trained personnel.

has shown that both methods are similarly effective in increasing body composition, strength (7, 8) and cardio-metabolic risk (4, 8). However, due to its exceptional time efficiency (7), joint friendliness and individualized setting, WB-EMS may be a good choice for people unable or simply unwilling to conduct intense resistance training protocols. However, in a recent letter to the British Medical Journal, Malnick et al. addressed the potential risks of WB-EMS and "the need to regulate the use of whole body electrical stimulation" (11). Indeed recent scientific literature has reported negative side-effects concerning WB-EMS induced increases in creatine-kinase up to a level of severe rhabdomyolysis (i.e. >50-fold increases compared with resting levels) (1, 2, 12).

Summarizing the mechanisms of exertional rhabdomyolysis, in general WB-EMS undeniably features most of the factors known to be associated with (resistance) exercise induced muscle damage and very pronounced muscle soreness (10). Especially the outstanding feature to innervate large muscle areas (12-14 electrodes with up to 2,800 cm^2) simultaneously, but with dedicated individual intensity per electrode/muscle group, may contribute to the problem of WB-EMS induced rhabdomyolysis, at least when applying too high (current) intensity. Thus, an adequate WB-EMS application is essential for preventing rhabdomyolysis and corresponding renal, hepatic and cardiac consequences.

In a recent study, we applied a typical but borderline exhaustive WB-EMS protocol (20min, bipolar, 85Hz, 350µs, rectangular, 6s of current, 4s of rest) to 37 healthy WB-EMS novices (6). And indeed, the CK increase after this borderline (too) intense initial WB-EMS application confirmed the reported exceptionally high CK-levels and very pronounced muscle soreness from 48h-96h (6). In detail, CK-concentration rose 117-fold (28545±33611 IU/l) with a peak after 72h and was 10 times higher compared with the CK-levels after a marathon run that was monitored in parallel (2795±883 IU/l after 48h). Although, we did not detect any of the reported clinical consequences of this "severe" rhabdomyolysis on renal and cardiac risk factors (15), in less fit and healthy subjects neither optimally prepared nor supervised, initial WB-EMS to exertion may have more far-reaching consequences.

Significantly, a subsequent WB-EMS conditioning phase of 10 weeks (1x20min WB-EMS/week, see above) completed by a second WB-EMS test session to exhaustion demonstrated a very pronounced "repeated bout effect" with individual CK-peaks all below 2000 IU/l (MV±SD: 906±500 IU/l), i.e. in the lower range of conventional resistance exercise training (6, 10). This result ›

indicates that a short period of careful WB-EMS conditioning should be mandatorily implemented in order to realize a safe application.

Conclusion

We conclude that the problem of WB-EMS induced rhabdomyolysis can be easily prevented with a minimum of common sense. Firstly, although some groups of highly motivated WB-EMS novices may request an exertional initial WB-EMS application, this approach should be strictly avoided. In parallel, no clear-thinking instructor would apply an intense eccentric resistance training protocol to muscular failure during the initial session to a resistance training novice. Secondly, as with conventional resistance exercise there is no need to focus on WB-EMS to exhaustion in order to generate relevant effects on body composition and functional capacity (3, 7). Additionally, contraindications for WB-EMS should be strictly heeded and WB-EMS novices adequately informed so as to ensure a safe and successful WB-EMS application. In order to realize the latter aim, in a German consensus conference in December 2015, WB-EMS manufacturers (miha-bodytec, Gersthofen, Germany), educational institutions (GluckerKolleg, Kornwestheim, Germany), Licensees (PT Lounge Köln, Cologne, Germany) and publishing researchers (see below) discussed the topic. Finally in April 2016, the scientific part of the consortium (Fröhlich, M.; Kemmler, W.; Kleinöder, H. v. Stengel, S.) has formulated a general guideline, that we would like to disseminate and publish here. We are aware that WB-EMS is a young and innovative technology with considerable further potential, thus extensions and changes of this guideline may be necessary in the nearest future. However, we think the general recommendations listed may be a first step to a more safe and effective WB-EMS application.

Conflict of Interest

The authors are aware that some commercial partners may have had a conflict of interest with respect to some issues. However, the final responsibility for the generation of this guideline clearly lies by the authors.

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