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Effects of electromyostimulation training on muscle strength and power of elite rugby players

Babault N, Cometti G, Bernardin M, Pousson M, Chatards JC

published in Journal of Strength and Conditioning Research 2007; 21(2), 431-437

The present study investigated the influence of a 12-week electromyostimulation (EMS) training program performed by elite rugby players. Twenty-five rugby players participated in the study, 15 in an electrostimulated group and the remaining 10 in a control group. EMS was conducted on the knee extensor, plantar flexor, and gluteus muscles. The first 6 weeks, training sessions were carried out 3 times a week and during the last 6 weeks, once a week. Isokinetic torque of the knee extensors was determined at different eccentric and concentric angular velocities ranging from -120 to 360° s^{-1}. Scrummaging and full squat strength, vertical jump height and sprint-running times were also evaluated. After the first 6 weeks of EMS, only the squat strength was significantly improved (+8.3 ± 6.5%; $p < 0.01$). After the 12th week, the -120° s^{-1} maximal eccentric, 120 and 240° s^{-1} maximal concentric torque ($p < 0.05$), squat strength (+15.0 ± 8.0%; $p < 0.001$), squat jump (+10.0 ± 9.5%; $p < 0.01$), and drop jump from a 40- cm height (+6.6 ± 6.1%; $p < 0.05$) were significantly improved. No significant change was observed for the control group. **A 12- week EMS training program demonstrated beneficial effects on muscle strength and power in elite rugby players on particular tests. However, rugby skills such as scrummaging and sprinting were not enhanced.**

2 Effects of an electrostimulation training program on strength, jumping, and kicking capacities in soccer players

Billot M, Martin A, Paizis C, Cometti C, Babault N
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The present study investigated the influence of a 5-week electrostimulation (EMS) training program on muscular strength, kicking velocity, sprint, and vertical jump performance in soccer players. Twenty amateur soccer players participated in the study, 10 in the electrostimulated group and the remaining 10 in a control group. Electrostimulation was applied on the quadriceps muscles over 5 weeks. Subjects were tested before, during (wk-3), and after (wk-5) the EMS training program. Maximal voluntary contraction using different contraction mode (i.e., eccentric, concentric, and isometric), vertical jump height, sprint running for 10 m, and ball speed were examined. We observed an increase in isometric and eccentric maximal knee extension torques and also a gain in ball speed performance without run up at wk-3. **After 5 weeks of EMS training, eccentric, isometric, and concentric torques and ball speed had significantly improved. It appeared appropriate to conduct EMS training during at least 3 weeks to observe beneficial effects in specific soccer skills such as ball speed.**

Electromyostimulation – a systematic review of the effects of different ems methods on selected strength parameters in trained and elite athletes

Filipovic A, Kleinöder H, Dörmann U, Mester J
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This is the first part of 2 studies that systematically review the current state of research and structure the results of selected electromyostimulation (EMS) studies in a way that makes accurate comparisons possible. This part will focus on the effects of EMS on strength enhancement. On the basis of these results, part 2 will deal with the influence of the training regimen and stimulation parameters on EMS training effectiveness to make recommendations for training control. Out of about 200 studies, 89 trials were selected according to predefined criteria: subject age (<35 years), subject health (unimpaired), EMS type (percutaneous stimulation), and study duration (>7 days). To evaluate these trials, we first defined appropriate categories according to the type of EMS (local or whole body) and type of muscle contraction (isometric, dynamic, isokinetic). Then, we established the most relevant strength parameters for high-performance sports: maximal strength, speed strength, power, jumping and sprinting ability. Unlike former reviews, this study differentiates between 3 categories of subjects based on their level of fitness (untrained subjects, trained subjects, and elite athletes) and on the types of EMS methods used (local, whole-body, combination). Special focus was on trained and elite athletes. Untrained athletes were investigated for comparison purposes. This scientific analysis revealed that EMS is effective for developing physical performance. After a stimulation period of 3-6 weeks, significant gains ($p < 0.05$) were shown in maximal strength (isometric Fmax +58.8%; dynamic Fmax +79.5%), speed strength (eccentric isokinetic Mmax +37.1%; concentric isokinetic Mmax + 41.3%; rate of force development + 74%; force impulse + 29%; vmax + 19%), and power (+67%). Developing these parameters increases vertical jump height by up to +25% (squat jump +21.4%, countermovement jump +19.2%, drop jump +12%) and improves sprint times by as much as -4.8% in trained and elite athletes. **With regard to the level of fitness, the analysis shows that trained and elite athletes, despite their already high level of fitness, are able to significantly enhance their level of strength to same extent as is possible with untrained subjects. The EMS offers a promising alternative to traditional strength training for enhancing the strength parameters and motor abilities described above. Because of the clear-cut advantages in time management, especially when whole-body EMS is used, we can expect this method to see the increasing use in high-performance sports.**

Effects of whole-body electromyostimulation on resting metabolic rate, body composition, and maximum strength in postmenopausal women: the Training and ElectroStimulation Trial

Kemmler W, Schliffka R, Mayhew JL, von Stengel, S.
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We evaluated the effect of whole-body electromyostimulation (WB-EMS) during dynamic exercises over 14 weeks on anthropometric, physiological, and muscular parameters in postmenopausal women. Thirty women (64.5 ± 5.5 years) with experience in physical training (> 3 years) were randomly assigned either to a control group (CON, n = 15) that maintained their general training program (2 x 60 min -wk^{-1} of endurance and dynamic strength exercise) or to an electromyostimulation group (WBEMS, n = 15) that additionally performed a 20-minute WB-EMS training (2 x 20 min -10 d^{-1}). Resting metabolic rate (RMR) determined from spirometry was selected to indicate muscle mass. In addition, body circumferences, subcutaneous skinfolds, strength, power, and dropout and adherence values. Resting metabolic rate was maintained in WB-EMS (-0.1 ± 4.8 kcal-h^{-1}) and decreased in CON (-3.2±5.2 kcal -h^{-1}, p = 0.038); although group differences were not significant (p = 0.095), there was a moderately strong effect size (ES = 0.62). Sum of skinfolds (28.6%) and waist circumference (22.3%) significantly decreased in WB-EMS whereas both parameters (1.4 and 0.1%, respectively) increased in CON (p = 0.001, ES= 1.37 and 1.64, respectively), whereas both parameters increased in CON (1.4 and 0.1%, respectively). Isometric strength changes of the trunk extensors and leg extensors differed significantly (p ≤ 0.006) between WB-EMS and CON (9.9% vs. -6.4%, ES = 1.53; 9.6% vs. -4.5%, ES = 1.43, respectively). **In summary, adjunct WB-EMS training significantly exceeds the effect of isolated endurance and resistance type exercise on fitness and fatness parameters. Further, we conclude that for elderly subjects unable or unwilling to perform dynamic strength exercises, electromyostimulation may be a smooth alternative to maintain lean body mass, strength, and power.**

Alternative exercise technologies to fight against Sarcopenia at old age: A series of studies and review

Kemmler W, von Stengel, S.
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The most effective physiologic mean to prevent sarcopenia and related muscle malfunction is a physically active lifestyle, or even better, physical exercise. However, due to time constraints, lack of motivation, or physical limitations, a large number of elderly subjects are either unwilling or unable to perform conventional workouts. In this context, two new exercise technologies, whole-body vibration (WBV) and whole-body electromyostimulation (WB-EMS), may exhibit a save, autonomous, and efficient alternative to increase or maintain muscle mass and function. **Regarding WB-EMS, the few recent studies indeed demonstrated highly relevant effects of this technology on muscle mass, strength, and power parameters at least in the elderly, with equal or even higher effects compared with conventional resistance exercise.** On the contrary, although the majority of studies with elderly subjects confirmed the positive effect of WBV on strength and power parameters, a corresponding relevant effect on muscle mass was not reported. However, well-designed studies with adequate statistical power should focus more intensely on this issue.

Whole-body electromyostimulation as a means to impact muscle mass and abdominal body fat in lean, sedentary, older female adults: subanalysis of the TEST-III trial

Kemmler W, von Stengel, S.
Published in Clinical Interventions in Aging 2013:8 1353-1364

Background: The primary aim of this study was to determine the effect of 12 months of whole-body electromyostimulation (WB-EMS) exercise on appendicular muscle mass and abdominal fat mass in subjects specifically at risk for sarcopenia and abdominal obesity, but unable or unwilling to exercise conventionally.

Methods: Forty-six lean, nonsportive (<60 minutes of exercise per week), elderly women (aged 75 ± 4 years) with abdominal obesity according to International Diabetes Federation criteria were randomly assigned to either a WB-EMS group (n=23) which performed 18 minutes of intermittent, bipolar WB-EMS (85 Hz) three sessions in 14 days or an "active" control group (n=23). Whole-body and regional body composition was assessed by dual energy X-ray absorptiometry to determine appendicular muscle mass, upper leg muscle mass, abdominal fat mass, and upper leg fat mass. Maximum strength of the leg extensors was determined isometrically by force plates.

Results: After 12 months, significant intergroup differences were detected for the primary endpoints of appendicular muscle mass (0.5% ± 2.0% for the WB-EMS group versus -0.8% ± 2.0% for the control group, P=0.025) and abdominal fat mass (-1.2% ± 5.9% for the WB-EMS group versus 2.4% ± 5.8% for the control group, P=0.038). Further, upper leg lean muscle mass changed favorably in the WB-EMS group (0.5% ± 2.5% versus -0.9% ± 1.9%, in the control group, P=0.033), while effects for upper leg fat mass were borderline nonsignificant (-0.8% ± 3.5% for the WB-EMS group versus 1.0% ± 2.6% for the control group, P=0.050). With respect to functional parameters, the effects for leg extensor strength were again significant, with more favorable changes in the WB-EMS group (9.1% ± 11.2% versus 1.0% ± 8.1% in the control group, P=0.010).

Conclusion: In summary, WB-EMS showed positive effects on the parameters of sarcopenia and regional fat accumulation. Further, considering the good acceptance of this technology by this nonsportive elderly cohort at risk for sarcopenia and abdominal obesity, WB-EMS may be a less off-putting alternative to impact appendicular muscle mass and abdominal fat mass, at least for subjects unwilling or unable to exercise conventionally.

Einfluss eines adjuvanten EMS-Trainings auf Körperzusammensetzung und kardiale Risikofaktoren bei älteren Männern mit Metabolischem Syndrom

Kemmler W, Birlauf A, von Stengel S.
Universität Erlangen-Nürnberg 2009

Problemstellung: Sarkopenie und (abdominale) Adipositas stehen mit Mortalität, Multimorbidität und Gebrechlichkeit („frailty“) des älteren Menschen in enger Verbindung. Inwieweit ein Ganzkörper- Elektromyostimulations (WB-EMS)-Training Einfluss auf Körperzusammensetzung und kardiale Risikofaktoren bei älteren Männern mit Metabolischem Syndrom nehmen kann, ist Ziel dieser Untersuchung.
Methoden: Insgesamt 28 Männer mit Metabolischem Syndrom gemäß IDF (69.4±2.8 Jahre) aus der Umgebung von Erlangen wurden nach Randomisierung einer Kontrollgruppe (KG: n=14) oder einer WB-EMS-Gruppe (n=14) zugeteilt. Das 14-wöchige Trainingsregime der WB-EMS sah alle 5 Tage ein 30-minütiges Ausdauer- und Kraftprogramm unter EMS-Applikation vor. Die Kontrollgruppe führte parallel ein Ganzkörpervibrations-Training mit dem Fokus „Steigerung der Beweglichkeit und des Wohlbefindens“ durch. Als primäre Endpunkte wurden die abdominale und Gesamtkörper-Fettmasse sowie die appendikuläre Skelettmuskelmasse (ASMM) ausgewählt. Sekundäre Endpunkte waren Parameter des Metabolischen Syndroms nach IDF (Taillenumfang, Glucose, Triglyzeride, HDLCholesterin, systolischer und diastolischer Blutdruck).
Ergebnisse: Die Veränderung der abdominalen Fettmasse zeigte bei hoher Effektstärke (ES): d`=1,33) signifikante Unterschiede (p=,004) zwischen WB-EMS und KG (-252±196 g, p=,001 vs. -34±103 g, p=,330). Parallel dazu verringerte sich in der WB-EMS-Gruppe das Gesamtkörperfett um -1350±876 g (p=,001) und in der KG um -291±850 g (p=,307) (Unterschied: p=,008, ES: d`=1,23). Die ASMM zeigte ebenfalls signifikante Unterschiede (p=,024, ES: d`=,97) zwischen EMS- und Vibrations- Kontrollgruppe (249±444 g, p=,066 vs. -298±638 g, p=,173). Mit der Ausnahme eines signifikanten Zwischengruppenunterschiedes (p=,023, ES: d`=1,10) für den Taillenumfang (EMS: -5,2±1,8, p=,000 vs. KG: -3,3±2,9 cm, p=,006) zeigten sich für die Parameter des Metabolischen Syndroms (s.o.) keine weiteren Effekte.
Diskussion: Ein Ganzkörper-EMS-Training zeigt bei geringem Trainingsvolumen (ca. 45 min/Woche) und kurzer Interventionsdauer (14 Wochen) signifikante Effekte auf die Körperzusammensetzung. Bei Menschen mit geringer kardialer und orthopädischer Belastbarkeit könnte somit WB-EMS eine entsprechende Alternative zu konventionellen Trainingsprogrammen sein.