Studies on electrical muscle stimulation

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EMS training can help to improve maximum strength and target specific muscle groups – leg, abdominal, arm and back muscles. Strength endurance and speed can also be trained with the help of EMS, resulting in improved sports performance. In particular, sprint time and jumping power can be enhanced by EMS training. In addition, some studies show the possibility of improving maximum oxygen consumption with the help of EMS training, which plays an important role in sports performance. Electrical muscle stimulation training has also turned out to be a suitable training supplement for certain sports such as soccer, swimming or tennis.

Maximum strength

Electrical muscle stimulation as whole-body training - multicenter study on the use of whole-body EMS in the gym

Aim of analysis

The study examined whether electrically stimulated whole-body training resulted in positive changes in strength, back pain, body image, anthropometry, mood, incontinence, and general health factors.

Methods

A total of 134 subjects, 102 women and 32 men with an average age of 42.5 years, were interviewed and tested before and after six weeks of training. They were compared with a control group consisting of 10 subjects (n=10) and by age and gender. Total whole-body EMS training sessions were performed twice a week for a total of 12 times. The training parameters were composed as follows: Pulse duration/ pause 4 s/4 s, 85 Hz, square pulses, pulse width 350µs. A training session consisted of a 10-15 minute familiarization session followed by 25 minutes of training with static exercise positions. Subsequently, a five-minute training program was performed with the following training parameters: (pulse duration 1 s, pulse pause 1 s, 100Hz, rectangular pulses, pulse width 150 µs). 18 subjects terminated the training prematurely.

Results

Maximum strength increased by 12.2% and strength endurance by 69.3%. Female subjects benefited more from the training than male subjects (13.6% vs. 7.3%). BMI and body weight remained about the same. Among female subjects, body circumference significantly reduced at the chest (- 0.7 cm), thigh (- 0.4 cm), waist (- 1.4 cm), and hips (- 1.1 cm). Among male subjects, waist circumference decreased (- 1.1 cm) with simultaneous increases in upper arms (+ 1.5 cm), chest (+ 1.2 cm), and thigh (+0.3 cm). No improvements were noted in the control group, while subjects in the control group had gained in hips and waist over the period.
In addition, 86.8% reported positive body sculpting effects. 90% perceived the EMS training as positive. 83% stated that they felt less tense and 89.1% felt more stability. Stronger improvements, especially in patients with complaints, were noted with height and intensities. However, greater muscle soreness also occurred here.

University of Bayreuth, 2003, J. Vatter.

The used EMS program is similar to the strength program by Antelope.

The effects of whole-body muscle stimulation on body composition and strength parameters: A protocol for systematic review and meta-analysis

Aim of analysis

The influence of whole-body electromyostimulation on body composition as well as strength within the adult relationship was analyzed.

Methods

The analysis includes clinical randomized trials. Within the intervention groups, all subjects must have completed the same exercises with a whole-body electrical stimulation suit. Those data from adult subjects who had no prior experience with whole-body EMS should be considered. Primary endpoints of this study are muscle mass or fat-free mass and percent fat or fat mass. Secondary endpoints are muscle and maximal strength.

Results

Body composition in women (pre- and post-menopausal) and in trained subjects has been effectively altered by whole-body electromyostimulation. Previous studies have also found an increase in performance and strength in the elderly, as well as in professional athletes. However, no systematic study has examined the effect of both variables in either group of persons.

2021, L. Rodriguez-Santana, J. C. Adsudar, G. Louro, J. Perez-Gomez.

The efficiency of EMS during tennis training: Antelope case study

Aim of analysis

The objective of the case study was to investigate the efficiency of EMS training during tennis training.

Methods

Antelope accompanied tennis player Sophia Bergner for three months. In addition to Sophia's normal training, she performed EMS training two to three times a week. After the three months, Sophia's strength and mobility were measured using FPZ equipment from the company DAVID.

Results

After the three months, the following strength gains were

measured for Sophia: Trunk extension increased by 12 percent, trunk flexion decreased by 5.4 percent. The punching movement or rotation with her right arm increased by 25.2 percent, with her left arm it was even 51.9 percent. Strength gains in rotation of both outer shoulder joints improved by 19.5 percent. Strength gains were also observed in her legs: The strength in her right leg improved by 6.4 percent, and that of her left leg improved by 17.1 percent. An improved strength gain of 29.2 percent was observed on the leg press, and the strength gain of knee flexion on both sides was 11.5 percent.

Publication year: 2022

Short- and long-term training effects of mechanical and electrical stimulation on strength diagnostic parameters

Methods

A total of 80 sports students from the German Sport University Cologne were randomized into the following 8 different training groups: EMS, maximal strength, rapid strength, strength endurance, vibration, hypertrophy, EMS/hypertrophy, vibration/hypertrophy. Subjects had strength training experience of at least two years and a sports fitness certificate. Training sessions were performed by the subjects twice a week for 4 weeks. Classical training and strength diagnostics were performed on the Leg Extension and a Leg Curl machine. After a warm-up on a bicycle ergometer, the strength diagnostic procedure was performed.

Results

An increase in maximum power could only be increased with the help of EMS training via the velocity component, with 40% additional load (29%). The velocity component, together with the strength component, determines dynamic performance. Even the training groups with typical maximal strength or rapid strength designs were able to significantly increase maximal performance only in conjunction with or exclusively via the strength component. Thus, at submaximal intensity, dynamic EMS training appears to offer new opportunities to increase practice-relevant maximal power.

German Sport University Cologne, 2009, J. Mester, S. Nowak, J. Schmithüsen, H. Kleinöder, U. Speicher.

Effects of Whole-Body Electromyostimulation versus High-Intensity Resistance Exercise on Body Composition and Strength: A Randomized Controlled Study

Aim of analysis

The object of the study was to investigate the influence of WB EMS (whole body ems) and HIT on muscle strength and body composition in middle-aged men. For this purpose, 48 untrained, healthy men aged between 30 and 50 years were randomly assigned to a WB-EMS group (3 sessions in two weeks) or a HIT group (2 sessions in one week). Both groups trained for a total of 16 weeks. The WB EMS group trained with intermittent stimulation (6 s WB-EMS, 4 s rest; 85 Hz, 350 µs) for 20 min and the HIT group as a “single-set-to-failure protocol.”

Results

In both groups, the changes in LBM (lean body mass) were significant (HIT 1.25% ± 1.44% vs. WB EMS). The differences between the groups were not significant. Back extensor strength and leg extensor strength increased in the WB EMS group and in the HIT group, but again no significant differences were recorded between groups. Corresponding to these changes, changes were also noted for body fat.

Conclusion

Based on the study results, WB EMS can be considered as a costly but at also time time-saving alternative to HIT resistance training for those individuals who want to achieve improvement in overall body and strength composition.

2016, W. Kemmler. M. Teschler, A. Weißenfels, M. Bebenek, M. Fröhlich, M. Kohl, S. von Stengel.

The used EMS program is similar to the strength program by Antelope.

Effect of electrical stimulation of high and low frequency on maximum isometric force and some morphological characteristics in men

Aim of analysis

The object of the study was to investigate the effects of two methods of electrical stimulation on calf circumference, skinfold thickness, and maximum isometric force of the stimulated and unstimulated (contralateral) legs.

Methods

The subjects consisted of 36 men who voluntarily participated in the study and were each assigned to one of three groups. Over a period of 21 days, subjects in groups 1 and 2 were stimulated daily with the electrical stimulation method of the triceps surae muscle. Group 1 was stimulated with a low frequency alternating current (50 Hz) and group 2 with a higher frequency alternating current (20000 Hz). The third group was the control group.

Results

The maximum isometric muscle strength of the stimulated (50.3% and 58.8%) and non-stimulated (contralateral) muscles in group 1 and group 2 increased significantly (39.7% and 32.2%). Such a significant increase in maximal isometric force was not observed in group 3 (control group). In both experimental groups, calf circumference also increased. In group 2, skinfold thickness decreased by 21.6%.

International Journal of Sports Medicine, 1987, M. Cabric, H. J. Appell.

Muscle training of the future: scientific and practical application of whole-body electromyostimulation training (WB EMS) with special emphasis on strength training

Methods

80 sports students trained the leg flexor and leg extensor muscles twice a week on training machines (company GYM80) in different groups (muscle building, strength endurance, maximum strength; in 3 series each). For this purpose, the subjects trained with different additional loads (30 to 90% of the individual maximum strength; 1 repetition maximum) with 3 to 15 repetitions. The sports students had at least 2 years of experience with strength training before the start of the study. Another group trained with whole-body EMS. For this, subjects in this group performed lunges and squats without additional load under electrical stimulation (3 series, 10 repetitions, load/pause 6 s/4s, pulse frequency 85Hz, pulse width350µs, rectangular pulse). Training would be twice weekly for 4 weeks. The subjects' dynamics were measured by power, which is composed of force and velocity and can be increased via these components.

Results

The leg extension and leg flexor muscle performance improved significantly in all groups that performed strength training. These improvements occurred across the strength factor, except in the whole-body EMS group and the mixed WB-EMS/muscle-building group. Only these two groups showed significant improvements in speed. The improvement in measured performance was via increased speed by approximately 30. Thus, speed, which is not easy to target, was improved within a short period of time. This could be due to the fact that the fast muscle fibers are directly targeted via electrical stimulation during whole-body EMS training. Furthermore, the results could show that whole-body EMS in combination with a dynamic execution of a movement can be a promising way of speed and strength training, as long as the whole-body EMS training is used in a well-dosed way.

Medicalsports network, 2007, H. Kleinöder.

The used EMS program is similar to the strength program by Antelope.

Electrical stimulation and swimming performance

Aim of analysis

The effects of electrostimulation training of 14 competitive swimmers on their swimming performance and strength of the latissimus dorsi muscle were to be investigated in the study.

Methods

For this purpose, the subjects were assigned to an electrostimulated training group (7 subjects) and a control group (7 subjects). With the help of an isokinetic dynamometer, the peak torques at different speeds (from -60 deg.s(-1) to 360 deg.s(-1)) during extension as well as flexion of the arm were to be registered. The subjects' performances were measured over a 50-meter freestyle swim as well as over a 25-meter pull buoy.

Results

A significant increase ($P < .05$) was recorded for peak torques under concentric, isometric, and eccentric conditions for the electrostimulated training group. There was also a significant decrease in swim times within the electrostimulation training group of 0.38 +/- 0.24 s for the 50-m freestyle and 0.19 +/- 0.14 s for the 25-m pull-buoy. No significant differences were found within the control group. Variations in peak torque (measured in the eccentric condition; -60 deg.s(-1)) were associated with variations in performance within the control group ($r = 0.77$; $P < 0.01$). Thus, it can be said that swimming performance as well as latissimus dorsi muscle strength of competitive swimmers can be improved with the help of an electrostimulated training program.

Medicine & Science in Sports & Exercise, 1995, F Pichon, J. C. Chatard, A. Martin, & G. Cometti.

Strength training by electromyostimulation? Empirical study on the strength effects of electromyostimulation training with variation of training duration

Aim of analysis

The aim of this stury was to investigate whether electromyostimulation training lasting less than 15 minutes would improve muscle strength and other parameters. It was also intended to measure the degree of muscle tissue stress caused by EMS training, the intensity, and indirectly the effectiveness of the training.

Methods

Fifty-five male sport students with a mean age of 22.9 years were randomly divided into two training groups: Group 1 trained for 5 minutes with EMS, and Group 2 trained for 10 minutes with EMS (n = 22 for each). In addition, there was a control group (n = 11). For a total of 6 weeks, the subjects trained twice a week with the following stimulation parameters: Pulse duration 4 s, pulse pause 4 s, frequency 80 Hz, pulse width 350 µs, bipolar square pulses. Dynamic maximum strength, strength endurance, body weight, body fat percentage, and CK (creatine kinase) levels were determined 24 hours after training. Body perception, mood, and state of mind were also determined.

Results

The dynamic strength endurance and maximum strength were increased highly significantly ($p \leq 0.001$) in both training groups: From up to 41% and 34%, respectively, in strength endurance and from up to 10% and 8%, respectively, in maximum strength. No significant difference in strength effects could be measured ($p > 0.05$). A significant weight gain of 0.83 % was determined for group 1 and 0.90 % for group 2. In contrast, no improvements were observed in body fat content. Creatine kinase levels were 595 U/l in group 1 and slightly higher at 761 U/l in group 2. Creatine kinase activity was primarily influenced by training intensity.

Conclusion

The strength increases did not improve with a shortened working time to 5 and 10 minutes, respectively, unlike with

previous studies. The results indicate that a training duration of approximately 15 minutes is considered optimal to achieve strength gains. The high increase in creatine kinase levels after EMS training indicates that the muscles were subjected to a very intense load. However, a shortened training duration does not decisively change the activity of the creatine kinase enzyme, but rather it seems that the current intensity plays an important role in increasing creatine kinase.

Unpublished diploma thesis, University of Bayreuth, 2006, W.-U. Boeck-Behrens, D. Mainka.

The used EMS program is similar to the strength program by Antelope.

Feasibility and Efficacy of Progressive Electrostimulation Strength Training for Competitive Tennis Players

Aim of analysis

The influence of electrostimulated strength exercises on anaerobic performance of tennis players during the preparation season was to be investigated in the study.

Methods

12 tennis players (7 female and 5 male) completed 9 training sessions for the quadriceps over 3 weeks, each lasting 16 minutes (frequency: 85 Hz; on-off ratio: 5.25-25 seconds). For this purpose, electrostimulated training sessions were integrated into the tennis training sessions. Shuttle sprint time, maximum quadriceps force, and vertical jump height were measured.

Results

Compared to the start of the study, jump height from countermovement was significantly higher at week five (+5.3%) and week six (+6.4%) ($p < 0.05$). In the sixth week, subjects showed a significantly shortened 2 x 10-meter sprint time (-3.3%) compared to pre-training ($p = 0.004$). The training parameters were linearly progressive within the 3-week training period. Thus, electrostimulated strength training was successfully integrated into the training. Anaerobic power and stretch-shortening cycle power exhibited delayed improvement throughout the study period. The study results indicate that progressive electrostimulated strength training can be integrated into the early tennis season and improve anaerobic performance for both women and men.

2009, N. Maffiuletti, J. Bramanti, M. Jubeau, M. Bizzini, G. Deley, G. Cometti.

Speed strength

Muscle training of the future: scientific and practical application of whole-body electromyostimulation training (WB EMS) with special emphasis on strength training.

Methods

80 sports students trained the leg flexor and leg extensor muscles twice a week on training machines (company GYM80) in different groups (muscle building, strength endurance, maximum strength; in 3 series each). For this purpose, the subjects trained with different additional loads (30 to 90% of the individual maximum strength; 1 repetition maximum) with 3 to 15 repetitions. The sports students had at least 2 years of experience with strength training before the start of the study. Another group trained with whole-body EMS. For this, subjects in this group performed lunges and squats without additional load under electrical stimulation (3 series, 10 repetitions, load/pause 6 s/4s, pulse frequency 85Hz, pulse width350µs, rectangular pulse). Training would be twice weekly for 4 weeks. The subjects' dynamics were measured by power, which is composed of force and velocity and can be increased via these components.

Results

The leg extension and leg flexor muscle performance improved significantly in all groups that performed strength training. These improvements occurred across the strength factor, except in the whole-body EMS group and the mixed WB-EMS/muscle-building group. Only these two groups showed significant improvements in speed. The improvement in measured performance was via increased speed by approximately 30. Thus, speed, which is not easy to target, was improved within a short period of time. This could be due to the fact that the fast muscle fibers are directly targeted via electrical stimulation during whole-body EMS training. Furthermore, the results could show that whole-body EMS in combination with a dynamic execution of a movement can be a promising way of speed and strength training, as long as the whole-body EMS training is used in a well-dosed way.

Medicalsports network, 2007, H. Kleinöder.

The used EMS program is similar to the strength program by Antelope.

The efficiency of EMS during tennis training: case study by Antelope

Aim of analysis

The objective of the case study was to investigate the efficiency of EMS training during tennis training.

Methods

Antelope accompanied tennis player Sophia Bergner for

three months. In addition to Sophia's normal training, she performed EMS training two to three times a week. After the three months, Sophia's strength and mobility were measured using FPZ equipment from the company DAVID.

Results

After the three months, the following strength gains were measured for Sophia: Trunk extension increased by 12 percent, trunk flexion decreased by 5.4 percent. The punching movement or rotation with her right arm increased by 25.2 percent, with her left arm it was even 51.9 percent. Strength gains in rotation of both outer shoulder joints improved by 19.5 percent. Strength gains were also observed in her legs: The strength in her right leg improved by 6.4 percent, and that of her left leg improved by 17.1 percent. An improved strength gain of 29.2 percent was observed on the leg press, and the strength gain of knee flexion on both sides was 11.5 percent.

Publication year: 2022

Effects of an Electrostimulation Training Program on Strength, Jumping, and Kicking Capacities in Soccer Players

Aim of analysis

To investigate the effects of a 5-week electrostimulation training program on shooting speed, muscle strength, sprinting as well as vertical jump performance of soccer players.

Methods

Twenty amateur soccer players participated in the study and were assigned to an electrostimulation group (n = 10) and a control group (n = 10). Electrostimulation was performed on the quadriceps muscles for 5 weeks. Measurements were taken before, during (week 3), and after (week 5) the EMS training program.

Results

An increase in eccentric maximal as well as isometric knee extension moments was observed in week 3. Additionally, improved ball speed without run-up was measured in week 3. The results suggest that EMS training should be performed for at least 3 weeks to achieve positive effects on specific soccer skills, such as ball speed.

2010, M. Billot, A. Martin, C. Paizis, C. Cometti, N. Babault.

Effects of simultaneously combined whole-body electrostimulation and plyometric training on vertical jump performance, 20 m sprint-time and handgrip strength

Aim of analysis

The object of the study was to investigate the influence of a 6-week training program combined of low-intensity plyometric training (PT) and whole-body electrical stimulation on 20-meter jump time, handgrip strength, and vertical jump performance. The results needed to be compared with those of traditional plyometric training.

Methods

20 sports students (10 female and 10 male) were randomly assigned to an experimental group or a control group. Over a 6-week period, both groups trained three times a week at low intensity. On the third day, the training in the experimental group was simultaneously combined with whole-body EMS. Peak counter movement jump (CMJ) performance, 20-meter sprint time, handgrip strength, and CMJ height were measured before and after the training period.

Results

CMJ height and peak CMJ power increased significantly in both groups, although the effect size was larger in the experimental group ($p < 0.001$, $g = 0.68$; $p < 0.001$, $g = 0.70$, respectively). No significant differences were measured between groups at follow-up. Handgrip strength increased in both groups. However, the effect sizes were minimal. In addition, a significant improvement in 20-meter sprint time was observed, but the effect size was larger in the control group ($p < 0.001$, $g = -1.68$). The combined program of plyometric training and whole-body EMS produced the best results for improving CMJ performance, and traditional plyometric training showed the most effective results for 20-meter sprint time.

2022, M. Á. Martín-Simón, D. Rojano-Ortega.

Electrical stimulation and swimming performance

Aim of analysis

The effects of electrostimulation training of 14 competitive swimmers on their swimming performance and strength of the latissimus dorsi muscle were to be investigated in the study.

Methods

For this purpose, the subjects were assigned to an electrostimulated training group (7 subjects) and a control group (7 subjects). With the help of an isokinetic dynamometer, the peak torques at different speeds (from -60 deg.s(-1) to 360 deg.s(-1)) during extension as well as flexion of the arm were to be registered. The subjects' performances were measured over a 50-meter freestyle swim as well as over a 25-meter pull buoy.

Results

A significant increase ($P < .05$) was recorded for peak torques under concentric, isometric, and eccentric conditions for the electrostimulated training group. There was also a significant decrease in swim times within the electrostimulation training group of 0.38 +/- 0.24 s for the 50-m freestyle and 0.19 +/- 0.14 s for the 25-m pull-buoy. No significant differences were found within the control group. Variations in peak torque (measured in the eccentric condition; -60 deg.s(-1)) were

associated with variations in performance within the control group ($r = 0.77$; $P < 0.01$). Thus, it can be said that swimming performance as well as latissimus dorsi muscle strength of competitive swimmers can be improved with the help of an electrostimulated training program.

Medicine & Science in Sports & Exercise, 1995, F Pichon, J. C. Chatard, A. Martin, & G. Cometti.

Short- and long-term training effects of mechanical and electrical stimulation on strength diagnostic parameters

Methods

A total of 80 sports students from the German Sport University Cologne were randomized into the following 8 different training groups: EMS, maximal strength, rapid strength, strength endurance, vibration, hypertrophy, EMS/hypertrophy, vibration/hypertrophy. Subjects had strength training experience of at least two years and a sports fitness certificate. Training sessions were performed by the subjects twice a week for 4 weeks. Classical training and strength diagnostics were performed on the Leg Extension and a Leg Curl machine. After a warm-up on a bicycle ergometer, the strength diagnostic procedure was performed.

Results

An increase in maximum power could only be increased with the help of EMS training via the velocity component, with 40% additional load (29%). The velocity component, together with the strength component, determines dynamic performance. Even the training groups with typical maximal strength or rapid strength designs were able to significantly increase maximal performance only in conjunction with or exclusively via the strength component. Thus, at submaximal intensity, dynamic EMS training appears to offer new opportunities to increase practice-relevant maximal power.

German Sport University Cologne, 2009, J. Mester, S. Nowak, J. Schmithüsen, H. Kleinöder, U. Speicher.

Effects of Electromyostimulation Training on Muscle Strength and Power of Elite Rugby Players

Aim of analysis

The object of the study was to examine the effects of a 12-week electromyostimulation training program on the performance of elite rugby players.

Methods

The subjects consisted of 25 rugby players. 15 of them were assigned to an electrostimulated group and 10 others to a control group. The training sessions were performed three times a week for the first six weeks and only once a week for the next six weeks. Electrical stimulation was performed on the glutes, foot flexors, and knee extensors. Sprint run times, vertical jump height, and knee flexor strength were also measured.

Results

Squat jump (+10.0 +/- 9.5%; $p < 0.01$), fall jump from a height of 40 centimeters (+6.6 +/- 6.1%; $p < 0.05$), knee flexion strength (+15.0 +/- 8.0%; < p 0.001), and maximum concentric torque ($p < 0.05$) improved in the electrostimulation group. There were no significant changes within the control group. Performance and muscle strength in elite rugby players improved after a 12-week electrostimulated training at least in certain tests, but rugby skills such as sprinting or scrummaging showed no such improvements.

Journal of Strength and Conditioning Research, 2007, N. Babault, G. Cometti, M. Bernardin, M. Pousson, J.-C. Chatard.

Power endurance

Electrical muscle stimulation as whole-body training - multicenter study on the use of whole-body EMS in the gym

Aim of analysis

The study examined whether electrically stimulated whole-body training resulted in positive changes in strength, back pain, body image, anthropometry, mood, incontinence, and general health factors.

Methods

A total of 134 subjects, 102 women and 32 men with an average age of 42.5 years, were interviewed and tested before and after six weeks of training. They were compared with a control group consisting of 10 subjects (n=10) and by age and gender. Total whole-body EMS training sessions were performed twice a week for a total of 12 times. The training parameters were composed as follows: Pulse duration/ pause 4 s/4 s, 85 Hz, square pulses, pulse width 350µs. A training session consisted of a 10-15 minute familiarization session followed by 25 minutes of training with static exercise positions. Subsequently, a five-minute training program was performed with the following training parameters: (pulse duration 1 s, pulse pause 1 s, 100Hz, rectangular pulses, pulse width 150 µs). 18 subjects terminated the training prematurely.

Results

Maximum strength increased by 12.2% and strength endurance by 69.3%. Female subjects benefited more from the training than male subjects (13.6% vs. 7.3%). BMI and body weight remained about the same. Among female subjects, body circumference significantly reduced at the chest (- 0.7 cm), thigh (- 0.4 cm), waist (- 1.4 cm), and hips (- 1.1 cm). Among male subjects, waist circumference decreased (- 1.1 cm) with simultaneous increases in upper arms (+ 1.5 cm), chest (+ 1.2 cm), and thigh (+0.3 cm). No improvements were noted in the control group, while subjects in the control group had gained in hips and waist over the period.
In addition, 86.8% reported positive body sculpting effects. 90% perceived the EMS training as positive. 83% stated that they felt less tense and 89.1% felt more stability. Stronger

improvements, especially in patients with complaints, were noted with height and intensities. However, greater muscle soreness also occurred here.

University of Bayreuth, 2003, J. Vatter.

The used EMS program is similar to the strength program by Antelope.

Changes in neuromuscular function after training by functional electrical stimulation

Aim of analysis

The aim of this study was to investigate whether there would be a change in the neuromuscular function of the flexor digitorium brevis (FDB) and rectus femoris (RF) after 6 weeks of training with functional electrical stimulation (FES). Also, whether the effects would persist after a recovery period of 6 weeks needed to be investigated.

Methods

Muscles were stimulated over a 6-week period (30 min/day, 5 days/week, total of 30 sessions). The stimulation pattern consisted of a biphasic symmetrical pulse current (10 V, i.e., submaximal) with ramp modulation of frequency (4-75-4 HZ) and pulse duration (400-100-400 µs). FES was administered via a clinical neurostimulator (Multiprocess 16+, Physitech; Electronique Médicale, Marseille, France).

Results

Immediately after functional electrical stimulation, a significant increase in maximum voluntary contraction (MVC) was observed in the recuts femoris and flexor digitorum brevis. This significant increase was still observed after 6 weeks of functional electrical stimulation. Functional electrical stimulation also resulted in a significant increase in endurance time to exhaustion (+18 ± 7%). In contrast, the unstimulated muscles showed no changes in endurance time to exhaustion and MCV. The results suggest that muscle function can be improved using functional electrical stimulation and that central muscle activation can be altered. For flexor digitorium brevis, the benefits of functional electrical stimulation were greater. Furthermore, in the present results, the benefits lasted longer in the FDB.

2003, T. Marqueste, F. Hug, P. Decherchi, Y. Jammes.

Strength training by electromyostimulation? Empirical study on the strength effects of electromyostimulation training with variation of training duration

Aim of analysis

The aim of this stury was to investigate whether electromyostimulation training lasting less than 15 minutes would improve muscle strength and other parameters. It was also intended to measure the degree of muscle tissue stress caused by EMS training, the intensity, and indirectly the effectiveness of the training.

Methods

Fifty-five male sport students with a mean age of 22.9 years were randomly divided into two training groups: Group 1 trained for 5 minutes with EMS, and Group 2 trained for 10 minutes with EMS (n = 22 for each). In addition, there was a control group (n = 11). For a total of 6 weeks, the subjects trained twice a week with the following stimulation parameters: Pulse duration 4 s, pulse pause 4 s, frequency 80 Hz, pulse width 350 µs, bipolar square pulses. Dynamic maximum strength, strength endurance, body weight, body fat percentage, and CK (creatine kinase) levels were determined 24 hours after training. Body perception, mood, and state of mind were also determined.

Results

The dynamic strength endurance and maximum strength were increased highly significantly ($p \leq 0.001$) in both training groups: From up to 41% and 34%, respectively, in strength endurance and from up to 10% and 8%, respectively, in maximum strength. No significant difference in strength effects could be measured ($p > 0.05$). A significant weight gain of 0.83 % was determined for group 1 and 0.90 % for group 2. In contrast, no improvements were observed in body fat content. Creatine kinase levels were 595 U/l in group 1 and slightly higher at 761 U/l in group 2. Creatine kinase activity was primarily influenced by training intensity.

Conclusion

The strength increases did not improve with a shortened working time to 5 and 10 minutes, respectively, unlike with previous studies. The results indicate that a training duration of approximately 15 minutes is considered optimal to achieve strength gains. The high increase in creatine kinase levels after EMS training indicates that the muscles were subjected to a very intense load. However, a shortened training duration does not decisively change the activity of the creatine kinase enzyme, but rather it seems that the current intensity plays an important role in increasing creatine kinase.

Unpublished diploma thesis, University of Bayreuth, 2006, W.-U. Boeck-Behrens, D. Mainka.

The used EMS program is similar to the strength program by Antelope.

The effects of neuromuscular electrical stimulation training on abdominal strength, endurance and selected anthropometric measures

Aim of analysis

The aim was to investigate the influence of neuromuscular electrical stimulation, self-administered, on changes in endurance, strength, selected anthropometric measures, as well as in satisfaction and shape of the abdominal region, perceived by the subjects.

Methods

On 5 days per week, 24 subjects stimulated their abdominal muscles for 20 to 40 minutes per session. The stimulation

took place over a period of 8 weeks. The subjects refrained from further exercise during this time. 16 additional subjects were assigned to a control group and refrained from abdominal training or other exercise during the period.

Results

Abdominal endurance increased by 100% in the stimulation group and by 28% in the control group. Within the stimulation group, abdominal muscle strength also increased by 58%, while the control group showed no change in this regard. Waist circumference decreased by 3.5 cm within the stimulation group. No significant change in waist circumference was observed in the control group. The feeling that their midsection appeared "firmer" and more toned was experienced by all 24 subjects in the stimulation group. In addition, they reported noticing improved posture as a result of the stimulation. Within the control group, none of the subjects reported this. Regarding body weight, BMI, and skinfold thickness, no significant differences were found in the stimulation and control groups. In the study, NMES led to significant improvements in endurance and muscle strength, as well as perceived satisfaction and shape of the abdominal region by subjects in the stimulation group.

2005, J. P. Porcari , J. Miller, K. Cornwell, C. Foster, M. Gibson, K. McLean, T. Kernoze.

Building and strengthening the musculature

Leg muscles

Strength Changes in the Normal Quadriceps Femoris Muscle as a Result of Electrical Stimulation

Aim of analysis

To what extent the normal quadriceps femoris muscle can be strengthened with the help of electrical muscle stimulation, without the support of a simultaneous isometric muscle contraction, should be investigated in the study.

Methods

A total of 58 subjects were randomly assigned to one of three independent groups. One group was trained with isometric strengthening of the quadriceps femoris muscle (n = 20), and another group was stimulated daily with the right quadriceps femoris muscle (n = 19). A third group served as a control group (n = 19).

Results

The torque of the quadriceps femoris muscle increased in each case in the group with isometric training and in the group with electrical stimulation ($p < .001$). Such significant change was not observed in the control group. The data support the use of this electronic stimulator as a suitable device for strengthening skeletal muscles without voluntary effort.

1983, R. K. Laughman, J. W. Youdas, T. R. Garrett, E. Y. S. Chao.

Changes in neuromuscular function after training by functional electrical stimulation

Aim of analysis

The aim of this study was to investigate whether a change in the neuromuscular function of the flexor digitorium brevis (FDB) and rectus femoris (RF) would appear after 6 weeks of training with functional electrical stimulation (FES). Also, whether the effects would persist after a recovery period of 6 weeks needed to be investigated.

Methods

Muscles were stimulated over a 6-week period (30 min/day, 5 days/week, total of 30 sessions). The stimulation pattern consisted of a biphasic symmetrical pulse current (10 V, i.e., submaximal) with ramp modulation of frequency (4-75-4 HZ) and pulse duration (400-100-400 µs). FES was administered via a clinical neurostimulator (Multiprocess 16+, Physitech; Electronique Médicale, Marseille, France).

Results

Immediately after functional electrical stimulation, a significant increase in maximum voluntary contraction (MVC) was observed in the recuts femoris and flexor digitorum brevis. This significant increase was still observed after 6 weeks of functional electrical stimulation. Functional electrical stimulation also resulted in a significant increase in endurance time to exhaustion (+18 ± 7%). In contrast, the unstimulated muscles showed no changes in endurance time to exhaustion and MCV. The results suggest that muscle function can be improved using functional electrical stimulation and that central muscle activation can be altered. For flexor digitorium brevis, the benefits of functional electrical stimulation were greater. Furthermore, in the present results, the benefits lasted longer in the FDB.

2003, T. Marqueste, F. Hug, P. Decherchi, Y. Jammes.

The efficiency of EMS during tennis training: case study by Antelope

Aim of analysis

The objective of the case study was to investigate the efficiency of EMS training during tennis training.

Methods

Antelope accompanied tennis player Sophia Bergner for three months. In addition to Sophia's normal training, she performed EMS training two to three times a week. After the three months, Sophia's strength and mobility were measured using FPZ equipment from the company DAVID.

Results

After the three months, the following strength gains were measured for Sophia: Trunk extension increased by 12 percent, trunk flexion decreased by 5.4 percent. The punching movement or rotation with her right arm increased by 25.2 percent, with her left arm it was even 51.9 percent. Strength gains in rotation of both outer shoulder joints improved by 19.5 percent. Strength gains were also observed in her legs: The strength in her right leg improved by 6.4 percent, and that of her left leg improved by 17.1 percent. An improved

strength gain of 29.2 percent was observed on the leg press, and the strength gain of knee flexion on both sides was 11.5 percent.

Publication year: 2022

On the effect of high-frequency EMS on muscle strength and muscle mass

Aim of analysis

Over a two-week period, female subjects exercised the gastrocnemius muscle with electrical stimulation.

Methods

Skinfold thickness, lower leg circumference, and maximum static plantar flexion force were measured before the start of the study and after the stimulation period.

Results

After the end of the stimulation period, the skinfold thickness of the subjects was significantly reduced. In addition, lower leg circumference had slightly increased highly significantly. The strength was also highly significantly increased. Based on the results, it can be suggested that the increase in strength that may result from electrical stimulation may be accompanied by an increase in muscle mass. Additionally, an improved intramuscular coordination can be assumed here.

German Journal of Sports Medicine, 1987, M. Cabric & H. J. Appell.

Improvement in Isometric Strength of the Quadriceps Femoris Muscle after Training with Electrical Stimulation

Aim of analysis

The study aimed to investigate whether the isometric force of the quadriceps femoris muscle can be significantly increased with the help of isometric training under electrical stimulation (ES). It also aimed to measure whether the relative strength and duration of the training contractions were related to the changes in strength.

Methods

A total of 24 subjects were assigned to an experimental group (n=12) and a control group (n=12). Subjects in both groups underwent pre-test and post-test. Thus, maximal voluntary isometric contractions (MVISCs) were determined. For four weeks, the experimental group trained three times a week with maximal tolerable isometric contractions induced by electrical stimulation.

Results

Both the experimental and control groups showed an increase in isometric strength of the quadriceps femoris muscle. However, the experimental group with electrical stimulation had a significantly greater increase ($p < .01$) in isometric training with electrical stimulation than the control group without electrical stimulation. In the experimental group, the relative strength improvement correlated with the intensity and duration of the training contraction. Moreover, the relative strength improvement was positive and significant in this group.

Physical Therapy, 1985, D.M. Selkowitz.

Feasibility and Efficacy of Progressive Electrostimulation Strength Training for Competitive Tennis Players

Aim of analysis

The influence of electrostimulated strength exercises on anaerobic performance of tennis players during the preparation season was to be investigated in the study.

Methods

12 tennis players (7 female and 5 male) completed 9 training sessions for the quadriceps over 3 weeks, each lasting 16 minutes (frequency: 85 Hz; on-off ratio: 5.25-25 seconds). For this purpose, electrostimulated training sessions were integrated into the tennis training sessions. Shuttle sprint time, maximum quadriceps force, and vertical jump height were measured.

Results

Compared to the start of the study, jump height from countermovement was significantly higher at week five (+5.3%) and week six (+6.4%) ($p < 0.05$). In the sixth week, subjects showed a significantly shortened 2 x 10-meter sprint time (-3.3%) compared to pre-training ($p = 0.004$). The training parameters were linearly progressive within the 3-week training period. Thus, electrostimulated strength training was successfully integrated into the training. Anaerobic power and stretch-shortening cycle power exhibited delayed improvement throughout the study period. The study results indicate that progressive electrostimulated strength training can be integrated into the early tennis season and improve anaerobic performance for both women and men.

2009, N. Maffiuletti, J. Bramanti, M. Jubeau, M. Bizzini, G. Deley, G. Cometti.

Augment in Voluntary Torque of Healthy Muscle by Optimization of Electrical Stimulation

Aim of analysis

The object of the study was to assess the effects of low-dose electrical stimulation on muscle torque improvement.

Methods

Six healthy women and nine healthy men (20 to 32 years of age) received electrical stimulation on the right anterior thigh muscle. The left leg was not electrically stimulated and served as a control. Electrical stimulation sessions were performed twice a week for five weeks. Electrical stimulation was repeated eight times per session. Each stimulation elicited isometric torque, with each stimulation producing isomet-

ric torque equal to 50% of the subject's maximum voluntary isometric contraction.

Results

Electrical stimulation was able to increase quadriceps femors torque in the male subjects of the study after it was used with low-dose and specified training features.

Physical Therapy, 1988, C.-L. Soo, D.P. Currier, A.J. Threlkeld.

Effects of Electromyostimulation Training on Muscle Strength and Power of Elite Rugby Players

Aim of analysis

The object of the study was to examine the effects of a 12-week electromyostimulation training program on the performance of elite rugby players.

Methods

The subjects consisted of 25 rugby players. 15 of them were assigned to an electrostimulated group and 10 others to a control group. The training sessions were performed three times a week for the first six weeks and only once a week for the next six weeks. Electrical stimulation was performed on the glutes, foot flexors, and knee extensors. Sprint run times, vertical jump height, and knee flexor strength were also measured.

Results

Squat jump (+10.0 +/- 9.5%; $p < 0.01$), fall jump from a height of 40 centimeters (+6.6 +/- 6.1%; $p < 0.05$), knee flexion strength (+15.0 +/- 8.0%; < p 0.001), and maximum concentric torque ($p < 0.05$) improved in the electrostimulation group. There were no significant changes within the control group. Performance and muscle strength in elite rugby players improved after a 12-week electrostimulated training at least in certain tests, but rugby skills such as sprinting or scrummaging showed no such improvements.

Journal of Strength and Conditioning Research, 2007. N. Babault, G. Cometti, M. Bernardin, M. Pousson, J.-C. Chatard.

Muscle training of the future: scientific and practical application of whole-body electromyostimulation training (WB EMS) with special emphasis on strength training

Methods

80 sports students trained the leg flexor and leg extensor muscles twice a week on training machines (company GYM80) in different groups (muscle building, strength endurance, maximum strength; in 3 series each). For this purpose, the subjects trained with different additional loads (30 to 90% of the individual maximum strength; 1 repetition maximum) with 3 to 15 repetitions. The sports students had at least 2 years of experience with strength training before the start of the study. Another group trained with whole-body EMS. For this, subjects in this group performed lunges and squats without additional load under electrical stimulation (3 series, 10 repetitions, load/pause 6 s/4s, pulse frequency 85Hz, pulse width350µs, rectangular pulse). Training would be twice weekly for 4 weeks. The subjects' dynamics were measured by power, which is composed of force and velocity and can be increased via these components.

Results

The leg extension and leg flexor muscle performance improved significantly in all groups that performed strength training. These improvements occurred across the strength factor, except in the whole-body EMS group and the mixed WB-EMS/muscle-building group. Only these two groups showed significant improvements in speed. The improvement in measured performance was via increased speed by approximately 30. Thus, speed, which is not easy to target, was improved within a short period of time. This could be due to the fact that the fast muscle fibers are directly targeted via electrical stimulation during whole-body EMS training. Furthermore, the results could show that whole-body EMS in combination with a dynamic execution of a movement can be a promising way of speed and strength training, as long as the whole-body EMS training is used in a well-dosed way.

Medicalsports network, 2007, H. Kleinöder.

The used EMS program is similar to the strength program by Antelope.

Effect of electrical stimulation on human skeletal muscle

Aim of analysis

The adaptive and acute effects of electrical stimulation on the quadriceps muscle should be examined in healthy male subjects.

Results

Four weeks of electrical stimulation improved muscle strength. This improvement resembled the results of a corresponding voluntary exercise program. The acute effects of electrical stimulation (the formation of lactate, the decrease in certain enzyme activities, and the depletion of glycogen and phosphagen stores) were similar to the effects previously recorded with intensive muscle training. No significant changes in muscle properties, mitochondrial properties, or enzyme activities were observed within four to five weeks after electrical stimulation. The effects of electrical stimulation on the quadriceps muscle appeared to be less "speed specific" and more "position specific" compared to the other training performed with slow isokinetic contractions.

International Journal of Sports Medicine, 1981, E. Eriksson, T. Haggmark, K. H. Kiessling & J. Karlsson.

Electromyostimulation training effects on neural drive and muscle architecture

Aim of analysis

The aim of the study was to investigate the influence of a four-week as well as an eight-week electromyostimulation training on the neural and muscular adaptations of the knee extensor muscle.

Methods

12 men were assigned to the electrostimulation group and 8 men to the control group. Subjects were tested at three time points: Before the start of the study, after 4 weeks, and after 8 weeks. In a total of 32 sessions, the training program was performed with isometric EMS. Neural adaptations were assessed using EMG activity as well as muscle activation measured under maximal voluntary contraction. The EMG responses and torque during electrically evoked contractions, the wide angle of the lateral vastus (VL), and the anatomical cross-sectional area of the muscle (ACSA) were examined to study the muscular changes.

Results

At week 8, a significant increase in normalized EMG activity of the vastus medialis and vastus lateralis muscles was observed (+69 and +39%, respectively, $P < 0.001$). No significant increase was observed for the rectus femoris muscle at week 8. Maximum voluntary contraction of the knee extensors increased significantly by 27% ($P < 0.001$) and was associated with VL pennation angle (+14%, $P < 0.001$), ACSA (physiological cross-sectional area) of the quadriceps (+6%, $P < 0.001$), and an increase in muscle activation (+6%, $P < 0.01$). At week 8, ACSA of the VM, VL, and vastus intermedius muscles had also significantly increased (5-8%, $P < 0.001$), but not at week 4. No changes were observed in the RF muscle.

Conclusion

The results suggest that voluntary torque (of the knee extensor muscle) can be increased after EMS training because of both neural and muscular adaptations. The changes selectively affected the monoarticular vastii muscles.

Medicine & Science in Sports & Exercise, 2005, J. Gondin, M. Guette, Y. Ballay, A. Martin.

Neural and muscular changes to detraining after electrostimulation training

Aim of analysis

The influence of a four-week training program following an eight-week training program with electrical stimulation on muscular and neuronal properties of the muscles of the knee extensor as well as on changes in muscle strength should be investigated.

Methods

9 subjects performed an eight-week training program consisting of 32 sessions of isometric electrical stimulation training. Subjects were tested before training, after the eight-week ES training, and after the four-week training.

Results

After training, a significant 26% increase in knee extensor torque was observed. This increase was accompanied by an increase in EMG activity of the vastus medialis muscle (normalized to the respective M-wave (+43%), muscle activation, and physiological cross-sectional area (ACSA) of the quadriceps (+6%). Knee extensor MVC values remained significantly (14%) above baseline values at the end of the study period. This was associated with greater ACSA of the quadriceps (3%), but not with greater neural activation. After completion of detraining, muscle activation (5%), MVC of the knee extensors (9%), EMG activity of the vastus medialis muscle (20%), and ACSA of the quadriceps (3%) increased significantly.

European Journal of Applied Physiology, 2006, J. Gondin, M. Guette, Y. Ballay & A. Martin.

Changes in Quadriceps Femoris Muscle Strength Using Isometric Exercise Versus Electrical Stimulation

Aim of analysis

The purpose of the study was to measure and compare the isometric and isokinetic torque of the quadriceps muscle.

Methods

Subjects were divided into three groups. Group 1 served as the control group (n=9) and was not allowed to change their daily activities for five weeks. Group 2 trained their quadriceps femoris muscle three times a week for five weeks with maximal voluntary isometric exercises (n=10). Group 3 trained contractions of the quadriceps femoris muscle three times a week for five weeks with electrical stimulation.

Results

The analysis of the results revealed significant increases in strength ($P < 0.05$) for both the electrostimulation and isometric exercise groups. No changes in strength were observed in the control group.

Journal of Orthopaedic and Sports Physical Therapy, 1987, R.J. Kubiak, K.M. Whitman, R.M. Johnston.

The Effect of Different Electro-Motor Stimulation Training Intensities on Strength Improvement

Aim of Analysis

The influence of electromotive stimulation (EMS) on quadriceps femoris strength gain should be investigated.

Methods

Randomly, 24 subjects were assigned to one of three groups:

One group exercised at 50% of maximal voluntary isometric contractions (high intensity, HI), and another group exercised at 25% of maximal isometric contractions (low intensity, LI). A third group served as a control group.

Results

After 3 weeks of EMS training program, significant improvement in strength was observed in both training groups. The increase in strength was significantly greater within the HI training group (48.5%) than in the LI training group (24.2%) ($p<0.01$). A three-week period of follow-up revealed a significant carry over effect, which was particularly prominent in the HI group. Positive isokinetic changes in concentric mode strength were also recorded in the training groups. Additionally, a significant cross-transfer effect was observed in the contralateral homologous muscle group of both training groups ($p<0.01$).

The Australian Journal of Physiotherapy, 1988, H.S. Lai, G. de Domenico, G.R. Straus.

The effects of electromyostimulation training and basketball practice on muscle strength and jumping ability

Aim of analysis

The effects of an electromyostimulation training program over 4 weeks on knee extensor strength and vertical jump performance in basketball players should be investigated.

Methods

10 basketball players trained three times a week with electrical stimulation. One session consisted of 48 contractions. Three tests were performed: One test before the start of the study, one test after four weeks of electromyostimulation training program, and one test after 4 weeks of normal basketball training.

Results

Isometric strength at the two angles adjacent to the training angle was increased by electromyostimulation training ($p < 0.01$). At week 4, jump from squat increased significantly by 14% ($p < 0.01$); jump from countermovement expressed no change. Isokinetic force increased significantly ($p < 0.05$) at eccentric and high concentric velocities (between 180 and 3608 × s-1), but not at low concentric velocities (60 and 1208 × s-). The increases in isometric and isokinetic strength during jump performance and squat jump were maintained at week eight. Power increased by 17% at week eight ($p < 0.01$). The basketball players, electromyostimulation, which served as part of a brief strength training program, improved squat jump performance and knee extensor strength.

2000, N. A. Maffiuletti, G. Cometti, I.G. Amiridis, A. Martin, M. Pousson, J. C. Chatard.

Neuromuscular adaptations to electrostimulation resistance training

Aim of analysis

The object of the study was to determine the effects of short-term resistance training with electrical stimulation on the neural and muscular adaptations of the weaker or less dominant quadriceps femoris muscle on healthy subjects.

Results

An increase in maximal voluntary force (+12%) was observed. This increase was accompanied by muscular (impairment of contractile properties of the whole muscle) and neural (increased muscle activation and cross-education effect) changes. In addition, significant changes in the cross-sectional area of single fibers (+27% for type 1 muscle fibers and +6% for type 2A muscle fibers), specific tension of type 1 fibers (+67%) but not of type 2A fibers, and relative myosin heavy chain (MHC) content (+22% for MHC-2A and -28% for MHC-2X) were detected. The changes that occurred at the level of individual muscle fibers as a result of resistance training with electrical stimulation were significant and primarily affected type 1 slow fibers.

2006, N. A. Maffiuletti, R. Zory, D. Miotti, M. A. Pellegrino, M. Jubeau, R. Bottinelli.

Strengthening of human quadriceps muscles by cutaneous electrical stimulation

Aim of analysis

The effects of electrical stimulation training on quadriceps strength should be investigated.

Methods

Sixteen healthy subjects were randomly assigned to two groups (an electrical stimulation group and an isometric group). All subjects trained four times a week for three weeks. The isometric training consisted of 10-second maximum contractions with 50-second rest periods per session.

Results

Quadriceps strength was significantly improved in both groups (22 +/- 5.3% in the electrical group and by 25 +/- 6.9% in the isometric group ($p < 0.02$)). Apparently, the strength did not change depending on the level of stimulation voltage (5-10 V) nor was it dependent on the induced voltage. There were no significant differences between the increases in strength ($p > 0.05$)). No muscle lesions, pain, or other adverse effects were noted within the electrical stimulation group. The results indicate that cutaneous electrical stimulation may be a viable option for strengthening. Cutaneous electrical stimulation appears to be a practical application for the rehabilitation of patients who are unable to perform effective voluntary contraction.

Journal of Rehabilitation Medicine, 1983, D.F. Miken, M. Todd-Smith & C. Thompson.

Effects of electromyostimulation training and volleyball practice on jumping ability

Aim of analysis

The influence of a four-week electromyostimulation training (EMS) program on the vertical jump performance of volleyball players should be investigated.

Methods

A total of 12 volleyball players participated in the study. EMS training sessions were integrated into the volleyball training three times per week. The knee extensor and plantar flexor muscles were stimulated simultaneously 20-22 times during the EMS training sessions for approximately 12 minutes.

Results

After completion of EMS training, countermovement jump and squat jump performance had not significantly changed, but mean power and mean height significantly increased by approximately 4%. ($p < 0,05$). At 10 days after completion of EMS training, a significant increase in jump height ($p < 0.05$) was observed for single jumps (SJ +6.5%, CMJ +5.4%). To the extent that EMS resistance training is intended to improve vertical jumping ability, sport-specific training following EMS training could allow the central nervous system to generate optimized control over neuromuscular properties.

The Journal of Strength and Conditioning Research, 2003, D. Malatesta, F. Cattaneo, S. Dugnani & N. A. Maffiuletti.

Back muscles

Effects of Whole-Body Electromyostimulation versus High-Intensity Resistance Exercise on Body Composition and Strength: A Randomized Controlled Study

Aim of analysis

The object of the study was to investigate the influence of WB EMS (whole body ems) and HIT on muscle strength and body composition in middle-aged men. For this purpose, 48 untrained, healthy men aged between 30 and 50 years were randomly assigned to a WB-EMS group (3 sessions in two weeks) or a HIT group (2 sessions in one week). Both groups trained for a total of 16 weeks. The WB EMS group trained with intermittent stimulation (6 s WB-EMS, 4 s rest; 85 Hz, 350 µs) for 20 min and the HIT group as a "single-set-to-failure protocol."

Results

In both groups, the changes in LBM (lean body mass) were significant (HIT 1.25% ± 1.44% vs. WB EMS). The differences between the groups were not significant. Back extensor strength and leg extensor strength increased in the WB EMS group and in the HIT group, but again no significant differences were recorded between groups. Corresponding to these changes, changes were also noted for body fat.

Conclusion

Based on the study results, WB EMS can be considered as a costly but at also time time-saving alternative to HIT resistance training for those individuals who want to achieve improvement in overall body and strength composition.

2016, W. Kemmler. M. Teschler, A. Weißenfels, M. Bebenek, M. Fröhlich, M. Kohl, S. von Stengel.

The used EMS program is similar to the strength program by Antelope.

Abdominal muscles

The effects of neuromuscular electrical stimulation training on abdominal strength, endurance and selected anthropometric measures

Aim of analysis

The aim was to investigate the influence of neuromuscular electrical stimulation, self-administered, on changes in endurance, strength, selected anthropometric measures, as well as in satisfaction and shape of the abdominal region, perceived by the subjects.

Methods

On 5 days per week, 24 subjects stimulated their abdominal muscles for 20 to 40 minutes per session. The stimulation took place over a period of 8 weeks. The subjects refrained from further exercise during this time. 16 additional subjects were assigned to a control group and refrained from abdominal training or other exercise during the period.

Results

Abdominal endurance increased by 100% in the stimulation group and by 28% in the control group. Within the stimulation group, abdominal muscle strength also increased by 58%, while the control group showed no change in this regard. Waist circumference decreased by 3.5 cm within the stimulation group. No significant change in waist circumference was observed in the control group. The feeling that their midsection appeared "firmer" and more toned was experienced by all 24 subjects in the stimulation group. In addition, they reported noticing improved posture as a result of the stimulation. Within the control group, none of the subjects reported this. Regarding body weight, BMI, and skinfold thickness, no significant differences were found in the stimulation and control groups. In the study, NMES led to significant improvements in endurance and muscle strength, as well as perceived satisfaction and shape of the abdominal region by subjects in the stimulation group.

2005, J. P. Porcari , J. Miller, K. Cornwell, C. Foster, M. Gibson, K. McLean, T. Kernoze.

Comparison of the Effects of Electrical Stimulation

and Exercise on Abdominal Musculature

Methods

32 subjects (21 women, 11 men) aged 20 to 40 years were randomly assigned to one of four groups: One group received electrical stimulation, one group performed exercises, another group performed exercises with concurrent electrical stimulation, and one group served as a control group. The study period was 4 weeks. The duration of sustained contraction and the number of repetitions were increased during this period by a value determined before the start of the study.

Results

Abdominal strength increased significantly the most within the electrical stimulation group. There was no significant change between groups in terms of endurance. Tissue resistance decreased, while current intensity and voltage increased significantly. It appeared that the combination of a training as well as stimulation could be the most effective method to improve the abdominal strength.

Journal of Orthopaedic and Sports Physical Therapy, 1987, G. Alon, S.A. McCombre, S. Koutsantonis, L.J. Stumphauzer, K.C. Burgwin, M.M. Parent, R.A. Bosworth.

Arm muscles

The efficiency of EMS during tennis training: case study by Antelope

Aim of analysis

The objective of the case study was to investigate the efficiency of EMS training during tennis training.

Methods

Antelope accompanied tennis player Sophia Bergner for three months. In addition to Sophia's normal training, she performed EMS training two to three times a week. After the three months, Sophia's strength and mobility were measured using FPZ equipment from the company DAVID.

Results

After the three months, the following strength gains were measured for Sophia: Trunk extension increased by 12 percent, trunk flexion decreased by 5.4 percent. The punching movement or rotation with her right arm increased by 25.2 percent, with her left arm it was even 51.9 percent. Strength gains in rotation of both outer shoulder joints improved by 19.5 percent. Strength gains were also observed in her legs: The strength in her right leg improved by 6.4 percent, and that of her left leg improved by 17.1 percent. An improved strength gain of 29.2 percent was observed on the leg press, and the strength gain of knee flexion on both sides was 11.5 percent.

Publication year: 2022

Oxygen consumption

Prolonged Electrical Muscle Stimulation Exercise Improves Strength, Peak VO2, and Exercise Capacity in Patients with Stable Chronic Heart Failure

Aim of analysis

The study was designed to find out what effects electrical muscle stimulation training has on patients with stable chronic heart failure.

Methods

10 Patients were randomly assigned to an 8-week exercise program or habitual activity for a crossover study (9 men, age 66 +/- 6.5 years).

Results

The mean values of maximal oxygen consumption, 6-minute walking distance, quadriceps strength, and body mass index at baseline were 19.5 +/- 3.5 mL x kg x min, 415.1 +/- 56.6m, 377.9 +/- 110.4N, and 27.9 +/- 3.1 kg/m, respectively(2). After finishing the training program, peak maximal oxygen consumption had increased to 21.2 +/- 5.1 mL x kg x min ($P < .05$), 6-min walking distance had increased to 454.9 +/- 54.5M ($P < .005$), and quadriceps strength had increased to 404.9 +/- 108.6N ($P < .005$). No significant effect was found for BMI ($P > .05$).

Conclusion

For sedentary adults who have stable chronic heart failure, EMS could improve physical fitness and functional performance. EMS may be an exercise alternative for patients who are unable to perform more conventional forms of physical activity.

2009, P. Banerjee, B. Caulfield, L. Crowe, A. L. Clark.

Electromyostimulation (EMS) improves exercise capacity and left ventricular function in patients with chronic heart failure

Aim of analysis

The purpose of the study was to investigate the influence of different stimulation options on important parameters of exercise tolerance in individuals with chronic heart failure.

Methods

Twenty-four stable patients (NYHA II-III) with chronic heart failure were recruited for an EMS training program. An EMS training program was performed twice weekly for 10 weeks. Per session, the training lasted 20 minutes. An EMS training device was used for the study. Electrical stimulation took place simultaneously on 8 major muscle areas (extensive EMS training; 12 patients; 9 male; mean age 62.17±12.6 years). These results were to be compared with a group in which patients received limited electrical stimulation to glu-

teal and thigh muscles (limEMS; 12 patients; 10 male; mean age 62.17±12.6 years). The effects on oxygen consumption, left ventricular function, exercise tolerance, and recognized biomarkers of chronic heart failure were investigated.

Results

The oxygen uptake at the anaerobic threshold increased significantly in both groups. In the exEMS group from 14.7±3.42 to 19.6±4.5 ml/kg/min (+32.65%, p<0.001) and in the limEMS group from 13.6±3.0 to 16.0±3.8 ml/kg/min (+17.6%, p=0.003). In the exEMS group, left ventricular ejection fraction increased from 38.42±7.6 to 45.21±8.6% (+18.42%, p=0.001) and in the limEMS group from 37.1±3.0 to 39.5±5.3% (+6.5%, p=0.27). The changes in terms of oxygen consumption and ejection fraction were greater in the exEMS group than in the limEMS group. The difference between the groups was not significant.

PERFUSION, 2013, F. van Buuren, K. P. Mellwig, C. Prinz, T. Kottmann, B. Körber, A. Fründ, L. Faber, N. Bogunovic, J. Dahm, D. Horstkotte, D. Fritzsche.

Oxygen consumption and muscle fatigue induced by whole-body electromyostimulation compared to equal-duration body weight circuit training

Aim of analysis

The study aimed to investigate the extent to which training with WB-EMS (whole-body electromystimulation) affects muscle fatigue and metabolic demand.

Methods

A total of 10 subjects participated in the study. An experimental group trained with whole-body EMS (5 exercises) and a control group performed five bodyweight exercises. The training sessions were 15 minutes each, they were based on isometric intermittent contractions (6 contractions with 4 seconds rest). Tests were performed to measure muscle fatigue using determination of force decrease: jump with countermovement, isometric mid-thigh pull, plyometric push-up. With the help of a measurement of respiratory gas exchange, the energy expenditure and oxygen consumption during the exercises were measured.

Results

A greater amount of energy consumption (WB-EMS 470 ± 71 kcal/h; control group 438 ±61 kcal/h, p = 0.013) and oxygen consumption (WB-EMS 1584 ± 251 ml/min; control group 1465 ± 216 ml/min, p = 0.006) was detected in the whole-body EMS group than in the control group. Whole-body EMS training resulted in muscle fatigue (all PRE vs. POST tests p ≤ 0.02), but not in the control group (all p > 0.14).

Sport Sciences for Health, 2016, G. Boccia, A. Fornasiero, A. Savoldelli, L. Bortolan, A. Rainoldi, F. Schena & B. Pellegrini.

HIT and EMS

Whole-body electromyostimulation versus HIT strength training - impact on body composition and muscle strength

Aim of analysis

The object of the study was to compare the effects of WB-EMS (whole body EMS) and HIT (high intensity training) on muscular parameters in healthy, untrained and working middle-aged men. For this purpose, 46 men aged between 30 and 50 years were randomly assigned to a WB-EMS and a HIT group. The study is to be understood as a training studio in parallel group design, which was conducted for 16 weeks.

Results

Total lean mass (LBM) changed significantly (p≤.003) in both groups (HIT: 1.24±1.40% vs. WB-EMS: 0.91±1.12%). No significant difference was found between the groups. Abdominal body fat mass (AF) and total body fat percentage (TF) also reduced significantly in both groups (-4.1±7.4% to 5.9±6.2%; p=.031 – p<.001). Again, there were no significant differences between the groups (TF: p=.975; AF: p=499). Favorable changes were noted in dynamic maximum strength of the leg extensors (HIT: 13.5±13.9%, p<.001 vs. WB-EMS: 8.0±10.2%, p=.008), but no significant differences (p=.332) were found between groups. This effect remained consistent even after adjusting for borderline (non) significant differences in basal values (p=.348). Static maximum strength of trunk extensors also showed no significant differences (HIT: 10.4±9.0%, p<.001 versus 11.7±9.9%, p<001) between the two groups.

2015, W. Kemmler, M. Teschler, A. Weissenfels M. Froehlich, M. Kohl, S. von Stengel.

Effekte von HIT vs. WB-EMS auf das kardiometabolische Risiko bei untrainierten Männern 30-50 Jahre

Aim of analysis

The aim of the study was to compare the influence of HIT (High Intensity Training) and WB-EMS (Whole Body EMS Training) on cardiometabolic risk factors in untrained middle-aged men (30-50 years).

Methods

Untrained men were randomized into two groups. One group trained for 16 weeks (bipolar, 20min, 85Hz, 350ms, intermittent), the other group also trained for 16 weeks with HIT training.

Results

Time effectiveness between the two groups showed comparable results in terms of net training time (~30min/TE; HIT: 60min/wk vs. WB-EMS: 30min/wk). The WB-EMS and also the HIT training showed significant improvements (p=.096) in terms of MetS-Z score (HIT: p=.031 vs. W B-EMS: p=.001) and abdominal fat content (HIT :-4.5±8.1%, p=.014 vs. W

B-EMS:-4.0±5.2%, p=.002). Cholesterol/HDL-C rates did not show significant changes between groups, although this was initially hypothesized (HIT: -2.7±7.4, p=.216 vs. W B-EMS: -2.2±10.2, p=.441).

Conclusion

The results indicate that both HIT and WB-EMS are comparably effective, economical, and attractive methods to reduce cardiometabolic risk factors in untrained middle-aged men. WB-EMS can be considered a training option that may be effective but high-cost and suitable for a target group that has low time resources and cannot perform classic HIT training.

Imp Erlangen, 2016, A. Weissenfels, M. Teschler, S. von Stengel, W. Kemmler, M. Bebenek.

The used EMS programm is similar to the strength program by Antelope.

Several studies show the possibility of reducing body fat percentage with the help of electrical muscle stimulation. In addition to improving physical fitness and sports performance, EMS training can also be helpful in relieving certain diagnosed ailments, such as pain and tension in the back. Also, EMS can be used to relieve incontinence. EMS training can also be a support on the way to a pain-free everyday life - and also in the prevention of such pain. According to researchers, people who have certain diseases, such as chronic heart failure, osteoporosis or sarcopenia, can also benefit from EMS training.

Reduction of body fat percentage

Whole-body electromyostimulation versus HIT strength training - impact on body composition and muscle strength

Aim of analysis

The object of the study was to compare the effects of WB-EMS (whole body EMS) and HIT (high intensity training) on muscular parameters in healthy, untrained and working middle-aged men. For this purpose, 46 men aged between 30 and 50 years were randomly assigned to a WB-EMS and a HIT group. The study is to be understood as a training studio in parallel group design, which was conducted for 16 weeks.

Results

Total lean mass (LBM) changed significantly (p≤.003) in both groups (HIT: 1.24±1.40% vs. WB-EMS: 0.91±1.12%). No significant difference was found between the groups. Abdominal body fat mass (AF) and total body fat percentage (TF) also reduced significantly in both groups (-4.1±7.4% to 5.9±6.2%; p=.031 - p<.001). Again, there were no significant differences between the groups (TF: p=.975; AF: p=499). Favorable changes were noted in dynamic maximum strength of the leg extensors (HIT: 13.5±13.9%, p<.001 vs. WB-EMS: 8.0±10.2%, p=.008), but no significant differences (p=.332) were found between groups. This effect remained consistent even after adjusting for borderline (non) significant differences in basal values (p=.348). Static maximum strength of trunk extensors also showed no significant differences (HIT: 10.4±9.0%, p<.001 versus 11.7±9.9%, p<001) between the two groups.

2015, W. Kemmler, M. Teschler, A. Weissenfels M. Froehlich, M. Kohl, S. von Stengel.

Electrical muscle stimulation as whole-body training - multicenter study on the use of whole-body EMS in the gym

Aim of analysis

The study examined whether electrically stimulated whole-body training resulted in positive changes in strength, back pain, body image, anthropometry, mood, incontinence, and general health factors.

Methods

A total of 134 subjects, 102 women and 32 men with an average age of 42.5 years, were interviewed and tested before and after six weeks of training. They were compared with a control group consisting of 10 subjects (n=10) and by age and gender. Total whole-body EMS training sessions were performed twice a week for a total of 12 times. The training parameters were composed as follows: Pulse duration/ pause 4 s/4 s, 85 Hz, square pulses, pulse width 350µs. A training session consisted of a 10-15 minute familiarization session followed by 25 minutes of training with static exercise positions. Subsequently, a five-minute training program was performed with the following training parameters: (pulse duration 1 s, pulse pause 1 s, 100Hz, rectangular pulses, pulse width 150 µs). 18 subjects terminated the training prematurely.

Results

BMI and body weight remained approximately the same in the subjects. For the female subjects, body circumference significantly reduced at the chest (- 0.7 cm), thighs (- 0.4 cm), waist (- 1.4 cm) and hips (- 1.1 cm). For the male subjects, waist circumference decreased (- 1.1 cm) with simultaneous increases in upper arms (+ 1.5 cm), chest (+ 1.2 cm), and thigh (+0.3 cm). No improvements were noted in the control group, while subjects in the control group had gained in hips and waist over the period.

In addition, 86.8% reported noticing positive body sculpting effects. 90% perceived the training as positive. 83% reported being less tense, 89.1% felt more stability. Stronger improvements, especially in patients with complaints, were noted with height and intensity. However, this also resulted in greater muscle soreness.

University of Bayreuth, 2003, J. Vatter.

The effects of neuromuscular electrical stimulation training on abdominal strength, endurance and selected anthropometric measures

Aim of analysis

The aim was to investigate the influence of neuromuscular electrical stimulation, self-administered, on changes in endurance, strength, selected anthropometric measures, as well as in satisfaction and shape of the abdominal region, perceived by the subjects.

Methods

On 5 days per week, 24 subjects stimulated their abdominal muscles for 20 to 40 minutes per session. The stimulation took place over a period of 8 weeks. The subjects refrained from further exercise during this time. 16 additional subjects were assigned to a control group and refrained from abdominal training or other exercise during the period.

Results

Abdominal endurance increased by 100% in the stimulation group and by 28% in the control group. Within the stimulation group, abdominal muscle strength also increased by 58%, while the control group showed no change in this regard. Waist circumference decreased by 3.5 cm within the stimulation group. No significant change in waist circumference was observed in the control group. The feeling that their midsection appeared “firmer” and more toned was experienced by all 24 subjects in the stimulation group. In addition, they reported noticing improved posture as a result of the stimulation. Within the control group, none of the subjects reported this. Regarding body weight, BMI, and skinfold thickness, no significant differences were found in the stimulation and control groups. In the study, NMES led to significant improvements in endurance and muscle strength, as well as perceived satisfaction and Shape of the abdominal region by subjects in the stimulation group.

2005, J. P. Porcari , J. Miller, K. Cornwell, C. Foster, M. Gibson, K. McLean, T. Kernoze.

WB EMS training and cardiometabolic risk in women 70+

Aim of analysis

Metabolic syndrome (MetS) includes the clinical parameters HDL-C, triglycerides, fasting glucose, mean arterial blood pressure (MAP), and waist circumference (according to the NCEP-ATP III criteria (2009)). The aim of the study was to find out what positive effects whole-body electromyostimulation (WB-EMS) has on the MetS.

Methods

For the study, 75 independently living women 70+ with sarcopenic obesity were recruited and randomly assigned to one of three supervised study groups. The groups performed whole-body electromyostimulation training (WB-EMS training) once a week for 20 minutes for six months (bipolar, 85Hz, 350ms, intermittent 4s current-4s current pause) with adjunctive protein addition (Wb-EMS+P) and without adjunctive protein addition (0.33g/kg/body weight). The control group was supposed to keep their lifestyle stable during the study period.

Results

The two training groups showed similar effects in terms of MetS-Z score (WB-EMS+protein:-0.89 ± 1.1 vs. WB-EMS: -0.46 ± 1.1; p=.49) at a comparable attendance rate. The between-group effect (p=.009) was due to negative trends in the control group. The WB-EMS+P group and the control group were significantly different from each other (p=.009), but the EMS and control groups were not (p=.150). The improvement in Z-score in the two training groups can be explained by significant changes in abdominal circumference and mean arterial blood pressure.

Conclusion

WB-EMS has shown to be effective in reducing risk factors of MetS in vulnerable women aged 70 years and older, in addition to being time efficient and joint-friendly execution.

Preliminary data from the Formosa study, Imp Erlangen, 2016, M. Teschler, A. Weissenfels, S. von Stengel, M. Bebenek, W. Kemmler.

The used program is similar to the strength program by Antelope.

Influence of adjunctive EMS training on body composition and cardiac risk factors in older men with metabolic syndrome

Methods

For the study, 28 men (69.4±2.8 years) with metabolic syndrome (according to IDF) were randomly assigned to a WB-EMS group (whole-body EMS training) (n=14) or a control group (KG; N=14). The WB-EMS group trained for 30 minutes every fifth day for 14 weeks with an endurance and strength program using EM.

Results

The abdominal fat mass changed significantly (p=.004) at high effect size ((ES): d`=1.33) between the WB-EMS and control groups (-252±196 g, p=.001 vs. -34±103 g, p=.330). Appendicular skeletal muscle mass also changed significantly (p=.024, ES: d`=.97) between the EMS and control groups (249±444 g, p=.066 vs. -298±638 g, p=.173). Total body fat decreased by -1350±876 g (p=.001) in the WB-EMS group and -291±850 g (p=.307) in the KG (difference: p=.008, ES: d`=1.23). There were also significant differences in waist circumference between groups (p=.023, ES: d`=1.10) (EMS: -5.2±1.8, p=.000 vs. KG: -3.3±2.9 cm, p=.006). There were no further effects for the other parameters of the metabolic syndrome.

The Test ll Trial, University of Erlangen-Nürnberg, 2009, W. Kemmler, A. Birlauf, S. von Stengel.

Relief from discomfort

Back pain

Electrical muscle stimulation as whole-body training - multicenter study on the use of whole-body EMS in the gym

Aim of analysis

The study examined whether electrically stimulated whole-body training resulted in positive changes in strength, back pain, body image, anthropometry, mood, incontinence, and general health factors.

Methods

A total of 134 subjects, 102 women and 32 men with an average age of 42.5 years, were interviewed and tested before and after six weeks of training. They were compared with a control group consisting of 10 subjects (n=10) and by age and gender. Total whole-body EMS training sessions were performed twice a week for a total of 12 times. The training parameters were composed as follows: Pulse duration/ pause 4 s/4 s, 85 Hz, square pulses, pulse width 350µs. A training session consisted of a 10-15 minute familiarization session followed by 25 minutes of training with static exercise positions. Subsequently, a five-minute training program was performed with the following training parameters: (pulse duration 1 s, pulse pause 1 s, 100Hz, rectangular pulses, pulse width 150 µs). 18 subjects terminated the training prematurely.

Results

82.3% reported that their back pain had improved and 29.9% that they were symptom-free after the training. Before the study began, 40.3% of subjects complained about chronic pain, compared to 9.3% after completion. 18 subjects terminated the training prematurely. No changes were noted within the control group.

According to the subjects, 83.0% suffered from less tension after completion of the study. 89.1% reported feeling more stability and 83.8% reported increased performance. Positive body sculpting effects were noted by 86.8% of subjects. Overall, 90% of subjects received the training as positive. Stronger improvements, especially in patients with complaints, were noted with height and intensities. However, also a stronger muscle soreness occurred. No changes were noted within the control group.

University of Bayreuth, 2003, J. Vatter.

Whole-body electromuscular stimulation (EMS training) against back pain

Methods

49 employees of the University of Bayreuth voluntarily participated in the study, 31 women as well as 18 men with an average age of 47 years, who reported having back complaints. The intensity and frequency of back complaints and the general state of discomfort were determined, as well as mood, vitality, body shaping and stability. A total of 10 EMS training sessions of 45 minutes each were performed 2 times per week.

Results

88.7% of the subjects reported that their back pain had reduced after completion of the study. 38.8% reported a strong reduction in back pain. According to the subjects' data, 41.9% experienced a slight improvement in their discomfort status and a significant reduction in the intensity and frequency of their discomfort. In addition, 61.4% of the subjects reported that their general discomfort status had improved. An improved mood was noted by 75.5%, increased vitality by 69.4%, positive body shaping effects by 50%, and perceived relaxation after training by 75.5%. An improvement in body stability was reported by 85.7% of the female and by 57.1% of the male subjects.

University of Bayreuth, 2002, W.-U. Boeckh-Behrens, N. Grützmacher, J. Sebelefsky.

Incontinence

Electrical muscle stimulation as whole-body training - multicenter study on the use of whole-body EMS in the gym

Aim of analysis

The study examined whether electrically stimulated whole-body training resulted in positive changes in strength, back pain, body image, anthropometry, mood, incontinence, and general health factors.

Methods

A total of 134 subjects, 102 women and 32 men with an average age of 42.5 years, were interviewed and tested before and after six weeks of training. They were compared with a control group consisting of 10 subjects (n=10) and by age and gender. Total whole-body EMS training sessions were performed twice a week for a total of 12 times. The training parameters were composed as follows: Pulse duration/ pause 4 s/4 s, 85 Hz, square pulses, pulse width 350µs. A training session consisted of a 10-15 minute familiarization session followed by 25 minutes of training with static exercise positions. Subsequently, a five-minute training program was performed with the following training parameters: (pulse duration 1 s, pulse pause 1 s, 100Hz, rectangular pulses, pulse width 150 µs). 18 subjects terminated the training prematurely.

Results

75.8% reported an improvement in incontinence. 33.3% were reported to be symptom-free thereafter. No changes were observed in the control group.

University of Bayreuth, 2003, J. Vatter.

The used program is similar to the strength program by Antelope.

Electromuscular stimulation (EMS) of the whole body muscles - an innovative method to relieve urinary incontinence

Methods

The study involved 49 people with back problems, in whom the presence, type and intensity of incontinence problems were determined. It was found that 17 subjects, 15 men and 2 women with an average age of 47 years, had a mostly

mild to moderate form of urinary incontinence. A total of 10 EMS training sessions were performed 2 times a week for 45 minutes each. The training sessions were composed of the following training parameters: Pulse duration 4 s, pulse pause 2 s, frequency 80 Hz, rise time 0 s, pulse width 350 µs. A training session lasted approximately 25 minutes, preceded by a 10-15 minute familiarization period during which the individual pulse strength was adjusted. During the training period, various static exercise positions were performed. This was followed by a five-minute relaxation program (pulse duration 1 s, pulse pause 1 s, frequency 100 Hz, rise time 0 s, pulse width 150 µs).

Results

64.7% of the patients reported relief from urinary incontinence symptoms, 23.5% reported freedom from symptoms. A reduction in symptoms was reported by 24.4%. 35.9% did not notice any change.

Unpublished diploma thesis, University of Bayreuth, 2002, W.-U. Boeckh-Behrens, G. Schäffer.

The used program is similar to the strength program by Antelope.

Support for diseases

Overweight

Effect of percutaneous electrical muscle stimulation on postprandial hyperglycemia in type 2 diabetes

Aim of analysis

The study aimed to investigate whether percutaneous electrical muscle stimulation (EMS) attenuates postprandial hyperglycemia in individuals with type 2 diabetes.

Methods

A total of eleven patients with type 2 diabetes participated in 2 experimental sessions. One session consisted of 30 minutes of electrical muscle stimulation after breakfast (EMS group) and the other session consisted of complete rest after breakfast (control group). In both groups, blood was sampled before the meal and 30, 60, 90, and 120 minutes after breakfast.

Results

In the EMS group, postprandial glucose levels were significantly decreased 60, 90, and 120 min after the meal ($p < 0.05$), as was C-peptide concentration ($p < 0.01$). Creatine phosphokinase (CPK) concentration was not significantly increased in either group.

Conclusion

The results suggest for the first time that electrical muscle stimulation may be a new exercise method for the treatment of postprandial hyperglycemia in individuals with type 2 diabetes. This may be particularly relevant for individuals who are unable to exercise sufficiently voluntarily due to obesity, orthopedic conditions, or severe diabetic complications.

2012, T. Miyamoto, K. Fukudab, T. Kimurac, Y. Matsubarab, K. Tsudaa, T. Moritania.

Metabolic syndrome

Influence of adjunctive EMS training on body composition and cardiac risk factors in older men with metabolic syndrome

Methods

For the study, 28 men (69.4±2.8 years) with metabolic syndrome (according to IDF) were randomly assigned to a WB-EMS group (whole-body EMS training) (n=14) or a control group (KG; N=14). The WB-EMS group trained for 30 minutes every fifth day for 14 weeks with an endurance and strength program using EM.

Results

The abdominal fat mass changed significantly (p=.004) at high effect size ((ES): d`=1.33) between the WB-EMS and control groups (-252±196 g, p=.001 vs. -34±103 g, p=.330). Appendicular skeletal muscle mass also changed significantly (p=.024, ES: d`=.97) between the EMS and control groups (249±444 g, p=.066 vs. -298±638 g, p=.173). Total body fat decreased by -1350±876 g (p=.001) in the WB-EMS group and -291±850 g (p=.307) in the KG (difference: p=.008, ES: d`=1.23). There were also significant differences in waist circumference between groups (p=.023, ES: d`=1.10) (EMS: -5.2±1.8, p=.000 vs. KG: -3.3±2.9 cm, p=.006). There were no further effects for the other parameters of the metabolic syndrome.

The Test II Trial, University of Erlangen-Nürnberg, 2009, W. Kemmler, A. Birlauf, S. von Stengel.

Effects of HIT Vs. WB-EMS on cardiometabolic risk in untrained men at the age between 30 to 50

Aim of analysis

The aim of the study was to compare the influence of HIT (High Intensity Training) and WB-EMS (Whole Body EMS Training) on cardiometabolic risk factors in untrained middle-aged men (30-50 years).

Methods

Untrained men were randomized into two groups. One group trained for 16 weeks (bipolar, 20min, 85Hz, 350ms, intermittent), the other group also trained for 16 weeks with HIT training.

Results

Time effectiveness between the two groups showed comparable results in terms of net training time (~30min/TE; HIT: 60min/wk vs. WB-EMS: 30min/wk). The WB-EMS and also the HIT training showed significant improvements (p=.096) in terms of MetS-Z score (HIT: p=.031 vs. W B-EMS: p=.001) and abdominal fat content (HIT:-4.5±8.1%, p=.014 vs. W B-EMS:-4.0±5.2%, p=.002). Cholesterol/HDL-C rates did not show significant changes between groups, although this was initially hypothesized (HIT: -2.7±7.4, p=.216 vs. W B-EMS: -2.2±10.2, p=.441).

Conclusion

The results indicate that both HIT and WB-EMS are comparably effective, economical, and attractive methods to reduce cardiometabolic risk factors in untrained middle-aged men. WB-EMS can be considered a training option that may be effective but high-cost and suitable for a target group that has low time resources and cannot perform classic HIT training.

Imp Erlangen, 2016, A. Weissenfels, M. Teschler, S. von Stengel, W. Kemmler, M. Bebenek.

The used EMS programm is similar to the strength program by Antelope.

WB EMS training and cardiometabolic risk in women 70+

Aim of analysis

Metabolic syndrome (MetS) includes the clinical parameters HDL-C, triglycerides, fasting glucose, mean arterial blood pressure (MAP), and waist circumference (according to the NCEP-ATP III criteria (2009)). The aim of the study was to find out what positive effects whole-body electromyostimulation (WB-EMS) has on the MetS.

Methods

For the study, 75 independently living women 70+ with sarcopenic obesity were recruited and randomly assigned to one of three supervised study groups. The groups performed whole-body electromyostimulation training (Wb-EMS training) once a week for 20 minutes for six months (bipolar, 85Hz, 350ms, intermittent 4s current-4s current pause) with adjunctive protein addition (Wb-EMS+P) and without adjunctive protein addition (0.33g/kg/body weight). The control group was supposed to keep their lifestyle stable during the study period.

Results

The two training groups showed similar effects in terms of MetS-Z score (WB-EMS+protein:-0.89 ± 1.1 vs. WB-EMS: -0.46 ± 1.1; p=.49) at a comparable attendance rate. The between-group effect (p=.009) was due to negative trends in the control group. The WB-EMS+P group and the control group were significantly different from each other (p=.009), but the EMS and control groups were not (p=.150). The improvement in Z-score in the two training groups can be explained by significant changes in abdominal circumference and mean arterial blood pressure.

Conclusion

WB-EMS has shown to be effective in reducing risk factors of MetS in vulnerable women aged 70 years and older, in addition to being time efficient and joint-friendly execution.

Preliminary data from the Formosa study, Imp Erlangen, 2016, M. Teschler, A. Weissenfels, S. von Stengel, M. Bebenek, W. Kemmler.

The used program is similar to the strength program by Antelope.

Chronic heart failure

Electromyostimulation (EMS) improves exercise capacity and left ventricular function in patients with chronic heart failure

Aim of analysis

The purpose of the study was to investigate the influence of different stimulation options on important parameters of exercise tolerance in individuals with chronic heart failure.

Methods

Twenty-four stable patients (NYHA II-III) with chronic heart failure were recruited for an EMS training program. An EMS training program was performed twice weekly for 10 weeks. Per session, the training lasted 20 minutes. An EMS training device available on the market was used for the study. Electrical stimulation took place simultaneously on 8 major muscle areas (extensive EMS training; 12 patients; 9 male; mean age 62.17±12.6 years). These results were to be compared with a group in which patients received limited electrical stimulation to gluteal and thigh muscles (limEMS; 12 patients; 10 male; mean age 62.17±12.6 years). The effects on oxygen uptake, left ventricular function, exercise tolerance, and recognized biomarkers of chronic heart failure were studied.

Results

Oxygen consumption at the anaerobic threshold increased significantly in both groups: In the exEMS group from 14.7±3.42 to 19.6±4.5 ml/kg/min (+32.65%, p<0.001) and in the limEMS group from 13.6±3.0 to 16.0±3.8 ml/kg/min (+17.6%, p=0.003). In the exEMS group, left ventricular ejection fraction increased from 38.42±7.6 to 45.21±8.6% (+18.42%, p=0.001) and in the limEMS group from 37.1±3.0 to 39.5±5.3% (+6.5%, p=0.27). The changes in terms of oxygen consumption and ejection fraction were greater in the exEMS group than in the limEMS group. The difference between the groups was not significant.

PERFUSION, 2013, F. van Buuren, K. P. Mellwig, C. Prinz, T. Kottmann, B. Körber, A. Fründ, L. Faber, N. Bogunovic, J. Dahm, D. Horstkotte, D. Fritzsche.

Prolonged Electrical Muscle Stimulation Exercise Improves Strength, Peak VO2, and Exercise Capacity in Patients with Stable Chronic Heart Failure

Aim of analysis

The study was designed to find out what effects electrical muscle stimulation training has on patients with stable chronic heart failure.

Methods

10 Patients were randomly assigned to an 8-week exercise program or habitual activity for a crossover study (9 men, age 66 +/- 6.5 years).

Results

The mean values of maximal oxygen consumption, 6-minute walking distance, quadriceps strength, and body mass index at baseline were 19.5 +/- 3.5 mL x kg x min, 415.1 +/- 56.6m, 377.9 +/- 110.4N, and 27.9 +/- 3.1 kg/m, respectively(2). After finishing the training program, peak maximal oxygen consumption had increased to 21.2 +/- 5.1 mL x kg x min ($P < .05$), 6-min walking distance had increased to 454.9 +/- 54.5M ($P < .005$), and quadriceps strength had increased to 404.9 +/- 108.6N ($P < .005$). No significant effect was found for BMI ($P > .05$).

Conclusion

For sedentary adults who have stable chronic heart failure, EMS could improve physical fitness and functional performance. EMS may be an exercise alternative for patients who are unable to perform more conventional forms of physical activity.

2009, P. Banerjee, B. Caulfield, L. Crowe, A. L. Clark.

Type 2 diabetes

Effect of percutaneous electrical muscle stimulation on postprandial hyperglycemia in type 2 diabetes

Aim of analysis

The study aimed to investigate whether percutaneous electrical muscle stimulation (EMS) attenuates postprandial hyperglycemia in individuals with type 2 diabetes.

Methods

A total of eleven patients with type 2 diabetes participated in 2 experimental sessions. One session consisted of 30 minutes of electrical muscle stimulation after breakfast (EMS group) and the other session consisted of complete rest after breakfast (control group). In both groups, blood was sampled before the meal and 30, 60, 90, and 120 minutes after breakfast.

Results

In the EMS group, postprandial glucose levels were significantly decreased 60, 90, and 120 min after the meal ($p < 0.05$), as was C-peptide concentration ($p < 0.01$). Creatine phosphokinase (CPK) concentration was not significantly increased in either group.

Conclusion

The results suggest for the first time that electrical muscle stimulation may be a new exercise method for the treatment of postprandial hyperglycemia in individuals with type 2 diabetes. This may be particularly relevant for individuals who are unable to exercise sufficiently voluntarily due to obesity, orthopedic conditions, or severe diabetic complications.

2012, T. Miyamoto, K. Fukudab, T. Kimurac, Y. Matsubarab, K. Tsudaa, T. Moritania.

Fit at old age

Osteoporosis

EMS training with osteoporosis

Methods

In a randomized and prospective study, 30 subjects with osteoporosis performed a training consistently for 4 months. One group (group A; n=10) trained with the “Back School” program, a second group (group B; n=10) trained with conventional equipment training, and a third group (group C; n=10) trained exclusively with EMS whole-body training. During the training period, concomitant medication was not modified.

Results

At the end of the study, improvements were seen in bone densitometry and physical capacity. However, these improvements were only significant in group C (EMS training).

Diploma thesis at the German University of Physical Culture and Sports, in cooperation with MedandSports, 2009, Th. Walluseck.

Sarcopenia

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

Aim of analysis

The study examined the effect of whole-body electromyostimulation training (WB-EMS) on appendicular muscle mass and abdominal fat mass in individuals at specific risk for sarcopenia and abdominal obesity and who are unwilling or

unable to exercise conventionally.
Methods

A total of 46 subjects were recruited for the study. Those subjects were lean, non-athletic women who exercised less than 60 minutes per week and had abdominal obesity according to International Diabetes Federation criteria. Randomly, 23 subjects were assigned to a WB-EMS group that performed 18 minutes of bipolar, intermittent WB-EMS (85 Hz) in three sessions over 14 days, and the remaining 23 were assigned to a control group. Appendicular muscle mass, thigh muscle mass, abdominal fat, and thigh fat mass were measured. Strength measurement plates were used to isometrically determine the maximum force of the leg extensors.

Results

Significant differences were noted between the two groups after 12 months for the primary end points 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). The muscle mass of the thighs of the subjects in the WB-EMS group changed positively (0.5% ± 2.5% versus -0.9% ± 1.9% in the control group, P=0.033). Fat mass of the thighs changed in a borderline non-significant manner (-0.8%±3.5% in the WB-EMS group versus 1.0%±2.6% in the control group, P=0.050). The functional parameters of leg extensor strength changed significantly, with the most favorable change in the WB-EMS group (9.1% ± 11.2% versus 1.0% ± 8.1% in the control group, P=0.010).

Conclusion

The study found overall positive effects of WB-EMS on the parameters of sarcopenia and regional fat accumulation. Because WB-EMS was well accepted in the non-athletic, older subjects at risk for sarcopenia and abdominal obesity, WB-EMS may be a less daunting alternative for affecting appendicular muscle mass and abdominal fat mass in individuals unable or unwilling to exercise conventionally.

Subanalysis of the TEST-III trial, Clinical Interventions in Aging, 2013, W. Kemmler, S. von Stengel.

Whole-body electromyostimulation for the prevention of sarcopenia in an elderly at-risk population

Aim of analysis

The aim of the study was to investigate the influence of whole-body electromyostimulation (WB-EMS) on body composition parameters and sarcopenia in women aged 70 years and older.

Methods

A total of 76 women with osteopenia, athletically inactive and lean and over 70 years of age, were randomly assigned to a WB-EMS group (n=38) or an active control group (akg; n=38). Over 54 weeks, the WB-EMS group performed a 20-minute light “exercise program” with EMS application 1.5 times per week. The control group performed (2 times 10 weeks, 1 time 60 min/week) light functional training with similar exercises. Regional and total lean body mass formed the primary endpoints of the study.

Results

Significant differences between the groups were observed in appendicular skeletal muscle mass (ASSM: WB-EMS: 62 ± 346 g vs. aKG: -233 ± 475 g), lean body mass (LBM: WB-EMS: 273 ± 589 g vs. aKG: -296 ± 977 g) and thigh ROI muscle mass (WB-EMS: 39 ± 223 g vs. aKG: -136 ± 237 g) (p = 0.005 - 0.008; ES: d` = 0.71 - 0.76). Leg strength also showed significant positive effects (p = 0.003, ES: d` = 0.97) in the WB-EMS group. No significant differences were recorded for body fat mass, appendicular fat mass, and thigh ROI fat mass (secondary study endpoints) (p = 0.459 - 0.865; ES: d` = 0.05 - 0.15). There was a high acceptance of WB-EMS training during the course of the study based on drop-out and attendance rates.

The TEST-III trial, German Journal of Sports Medicine, 2012, W. Kemmler, K. Engelke, S. von Stengel.

Review of the evidence on the use of electrical muscle stimulation to treat sarcopenia

Aim of analysis

The review should provide a detailed overview of the extent to which physiological changes can occur through EMS. The starting point for this review is that EMS has been shown to improve and increase muscle strength and mass, respectively, so it can be assumed that EMS can also be used to treat sarcopenia. For the review, only clinical and experimental human studies were chosen as reference articles.

Conclusion

The high-frequency electrical stimulation appears o have primary effects on muscle mass gain. Low-frequency electrical stimulation, on the other hand, appears to favor increases in muscle mass. Improvements in oxidative enzymatic activity and glucose uptake, as well as changes in muscle fiber composition, appear to be promoted by EMS.

2016, M.M. Nishidaa, T. Tsuboyamaa, T. Moritanib, H. Araiac.

Incontinence

Electrical muscle stimulation as whole-body training - multicenter study on the use of whole-body EMS in the gym

Aim of analysis

The study examined whether electrically stimulated whole-body training resulted in positive changes in strength, back pain, body image, anthropometry, mood, incontinence, and general health factors.

Methods

A total of 134 subjects, 102 women and 32 men with an average age of 42.5 years, were interviewed and tested before and after six weeks of training. They were compared with a control group consisting of 10 subjects (n=10) and by age and gender. Total whole-body EMS training sessions were performed twice a week for a total of 12 times. The training parameters were composed as follows: Pulse duration/ pause 4 s/4 s, 85 Hz, square pulses, pulse width 350µs. A training session consisted of a 10-15 minute familiarization session followed by 25 minutes of training with static exercise positions. Subsequently, a five-minute training program was performed with the following training parameters: (pulse duration 1 s, pulse pause 1 s, 100Hz, rectangular pulses, pulse width 150 µs). 18 subjects terminated the training prematurely.

Results

75.8% reported an improvement in incontinence. 33.3% were reported to be symptom-free thereafter. No changes were observed in the control group.

University of Bayreuth, 2003, J. Vatter.

The used program is similar to the strength program by Antelope.

Electromuscular stimulation (EMS) of the whole body muscles - an innovative method to relieve urinary incontinence

Methods

The study involved 49 people with back problems, in whom the presence, type and intensity of incontinence problems were determined. It was found that 17 subjects, 15 men and 2 women with an average age of 47 years, had a mostly mild to moderate form of urinary incontinence. A total of 10 EMS training sessions were performed 2 times a week for 45 minutes each. The training sessions were composed of the following training parameters: Pulse duration 4 s, pulse pause 2 s, frequency 80 Hz, rise time 0 s, pulse width 350 µs. A training session lasted approximately 25 minutes, preceded by a 10-15 minute familiarization period during which the individual pulse strength was adjusted. During the training period, various static exercise positions were performed. This was followed by a five-minute relaxation program (pulse duration 1 s, pulse pause 1 s, frequency 100 Hz, rise time 0 s, pulse width 150 µs).

Results

64.7% of the patients reported relief from urinary incontinence symptoms, 23.5% reported freedom from symptoms. A reduction in symptoms was reported by 24.4%. 35.9% did not notice any change.

Unpublished diploma thesis, University of Bayreuth, 2002. W.-U. Boeckh-Behrens, G. Schäffer.

The used program is similar to the strength program by Antelope

Metabolic syndrome

Influence of adjunctive EMS training on body composition and cardiac risk factors in older men with metabolic syndrome

Methods

For the study, 28 men (69.4±2.8 years) with metabolic syndrome (according to IDF) were randomly assigned to a WB-EMS group (whole-body EMS training) (n=14) or a control group (KG; N=14). The WB-EMS group trained for 30 minutes every fifth day for 14 weeks with an endurance and strength program using EM.

Results

The abdominal fat mass changed significantly (p=.004) at high effect size ((ES): d`=1.33) between the WB-EMS and control groups (-252±196 g, p=.001 vs. -34±103 g, p=.330). Appendicular skeletal muscle mass also changed significantly (p=.024, ES: d`=.97) between the EMS and control groups (249±444 g, p=.066 vs. -298±638 g, p=.173). Total body fat decreased by -1350±876 g (p=.001) in the WB-EMS group and -291±850 g (p=.307) in the KG (difference: p=.008, ES: d`=1.23). There were also significant differences in waist circumference between groups (p=.023, ES: d`=1.10) (EMS: -5.2±1.8, p=.000 vs. KG: -3.3±2.9 cm, p=.006). There were no further effects for the other parameters of the metabolic syndrome.

The TEST ll-trial, University of Erlangen-Nürnberg, 2009, W. Kemmler, A. Birlauf, S. von Stengel.

Effects of HIT Vs. Wb-EMS on cardiometabolic risk in untrained men at the age between 30 to 50

Aim of analysis

The aim of the study was to compare the influence of HIT (High Intensity Training) and WB-EMS (Whole Body EMS Training) on cardiometabolic risk factors in untrained middle-aged men (30-50 years).

Methods

Untrained men were randomized into two groups. One group trained for 16 weeks (bipolar, 20min, 85Hz, 350ms, intermittent), the other group also trained for 16 weeks with HIT training.

Results

Time effectiveness between the two groups showed comparable results in terms of net training time (~30min/TE; HIT: 60min/wk vs. WB-EMS: 30min/wk). The WB-EMS and also the HIT training showed significant improvements (p=.096) in terms of MetS-Z score (HIT: p=.031 vs. W B-EMS: p=.001) and abdominal fat content (HIT:-4.5±8.1%, p=.014 vs. W B-EMS:-4.0±5.2%, p=.002). Cholesterol/HDL-C rates did not show significant changes between groups, although this was initially hypothesized (HIT: -2.7±7.4, p=.216 vs. W B-EMS: -2.2±10.2, p=.441).

Conclusion

The results indicate that both HIT and WB-EMS are comparably effective, economical, and attractive methods to reduce cardiometabolic risk factors in untrained middle-aged men. WB-EMS can be considered a training option that may be effective but high-cost and suitable for a target group that has low time resources and cannot perform classic HIT training.

Imp Erlangen, 2016, A. Weissenfels, M. Teschler, S. von Stengel, W. Kemmler, M. Bebenek.

The used EMS programm is similar to the strength program by Antelope.

WB EMS training and cardiometabolic risk in women 70+

Aim of analysis

Metabolic syndrome (MetS) includes the clinical parameters HDL-C, triglycerides, fasting glucose, mean arterial blood pressure (MAP), and waist circumference (according to the NCEP-ATP III criteria (2009)). The aim of the study was to find out what positive effects whole-body electromyostimulation (WB-EMS) has on the MetS.

Methods

For the study, 75 independently living women 70+ with sarcopenic obesity were recruited and randomly assigned to one of three supervised study groups. The groups performed whole-body electromyostimulation training (Wb-EMS training) once a week for 20 minutes for six months (bipolar, 85Hz, 350ms, intermittent 4s current-4s current pause) with adjunctive protein addition (Wb-EMS+P) and without adjunctive protein addition (0.33g/kg/body weight). The control group was supposed to keep their lifestyle stable during the study period.

Results

The two training groups showed similar effects in terms of MetS-Z score (WB-EMS+protein:-0.89 ± 1.1 vs. WB-EMS: -0.46 ± 1.1; p=.49) at a comparable attendance rate. The between-group effect (p=.009) was due to negative trends in the control group. The WB-EMS+P group and the control group were significantly different from each other (p=.009), but the EMS and control groups were not (p=.150). The improvement in Z-score in the two training groups can be explained by significant changes in abdominal circumference and mean arterial blood pressure.

Conclusion

WB-EMS has shown to be effective in reducing risk factors of MetS in vulnerable women aged 70 years and older, in addition to being time efficient and joint-friendly execution.

Preliminary data from the Formosa study, Imp Erlangen, 2016, M. Teschler, A. Weissenfels, S. von Stengel, M. Bebenek, W. Kemmler.

The used program is similar to the strength program by Antelope.

Chronic heart failure

Electromyostimulation (EMS) improves exercise capacity and left ventricular function in patients with chronic heart failure

Aim of analysis

The purpose of the study was to investigate the influence of different stimulation options on important parameters of exercise tolerance in individuals with chronic heart failure.

Methods

Twenty-four stable patients (NYHA II-III) with chronic heart failure were recruited for an EMS training program. An EMS training program was performed twice weekly for 10 weeks. Per session, the training lasted 20 minutes. An EMS training device available on the market was used for the study. Electrical stimulation took place simultaneously on 8 major muscle areas (extensive EMS training; 12 patients; 9 male; mean age 62.17±12.6 years). These results were to be compared with a group in which patients received limited electrical stimulation to gluteal and thigh muscles (limEMS; 12 patients; 10 male; mean age 62.17±12.6 years). The effects on oxygen uptake, left ventricular function, exercise tolerance, and recognized biomarkers of chronic heart failure were studied.

Results

Oxygen consumption at the anaerobic threshold increased significantly in both groups: In the exEMS group from 14.7±3.42 to 19.6±4.5 ml/kg/min (+32.65%, p<0.001) and in the limEMS group from 13.6±3.0 to 16.0±3.8 ml/kg/min (+17.6%, p=0.003). In the exEMS group, left ventricular ejection fraction increased from 38.42±7.6 to 45.21±8.6% (+18.42%, p=0.001) and in the limEMS group from 37.1±3.0 to 39.5±5.3% (+6.5%, p=0.27). The changes in terms of oxygen consumption and ejection fraction were greater in the exEMS group than in the limEMS group. The difference between the groups was not significant.

PERFUSION, 2013, F. van Buuren, K. P. Mellwig, C. Prinz, T. Kottmann, B. Körber, A. Fründ, L. Faber, N. Bogunovic, J. Dahm, D. Horstkotte, D. Fritzsche.

Prolonged Electrical Muscle Stimulation Exercise Improves Strength, Peak VO2, and Exercise Capacity in Patients With Stable Chronic Heart Failure

Aim of analysis

The study was designed to find out what effects electrical muscle stimulation training has on patients with stable chronic heart failure.

Methods

10 Patients were randomly assigned to an 8-week exercise program or habitual activity for a crossover study (9 men, age 66 +/- 6.5 years).

Results

The mean values of maximal oxygen consumption, 6-minute walking distance, quadriceps strength, and body mass index at baseline were 19.5 +/- 3.5 mL x kg x min, 415.1 +/- 56.6m, 377.9 +/- 110.4N, and 27.9 +/- 3.1 kg/m, respectively(2). After finishing the training program, peak maximal oxygen consumption had increased to 21.2 +/- 5.1 mL x kg x min ($P < .05$), 6-min walking distance had increased to 454.9 +/- 54.5M ($P < .005$), and quadriceps strength had increased to 404.9 +/- 108.6N ($P < .005$). No significant effect was found for BMI ($P > .05$).

Conclusion

For sedentary adults who have stable chronic heart failure, EMS could improve physical fitness and functional performance. EMS may be an exercise alternative for patients who are unable to perform more conventional forms of physical activity.

2009, P. Banerjee, B. Caulfield, L. Crowe, A. L. Clark.

Glossary

Anaerobic threshold
the highest intensity of exertion that a person can sustain for an extended period of time while achieving a state of equilibrium between the formation and degradation of lactate (salt of lactic acid in the muscles).

Anthropometry
science of human body and skeletal features and their exact determination.

Carry over effect
influence of a therapy by a previous treatment.

Chronic heart failure
progressive heart disease in which the heart's ability to pump blood decreases to the point that not enough blood and therefore oxygen and nutrients can be pumped to organs.

Creatine kinase (CK)
enyzm used for the diagnosis of muscle diseases.

Crossing effect
bilateral muscle is only trained on one side and leads to an increase in strength of the muscle on the opposite side.

Electromyostimulation
„Myo" means muscle. The term means „electrical muscle stimulation".

EMG activity
EMG stands for „electromyography". Electromyographic examination measures the electrical activity of specific muscles, which can be used to assess muscle and nerve function.

Functional electrostimulation (FES)
allows to address nerves that the central nervous system does not manage to control.

High Intensity Training (HIT)
workout with a short period of time but at the same time intense exercises.

Hypertrophy
excessive increase in size of tissues and organs due to enlargement of cells (especially because of increased exertion).

Isometric training
strength training during which the muscle is under maximum sustained tension (isometric contraction) by holding a push or pull for as long as possible.

Left ventricular
relating to the left ventricle of the heart.

Maximum force
maximum force that a person's neuromuscular system can voluntarily exert against a resistance.

MCV value (mean corpuscular volume)
indicates the average volume of a red blood cell.

Metabolic syndrome
combination of the following risk factors: too much abdominal fat, high blood fat and blood sugar levels as well as high blood pressure.

Neuromuscular electrical stimulation
triggering of contractions of muscle groups or individual muscles using an electrical stimulus (can be compared to electrical muscle stimulation).

Obesity
excessive body weight caused by excess fat.

Postprandial hyperglycemia
refers to elevated blood glucose levels after a meal.

Sarcopenia
describes the increasing loss of muscle strength and mass with advancing age.

Speed strength
ability of the human neuromuscular system to produce the largest possible impulse of force within a short period of time.

Strength endurance
ability of the body to sustain a dynamic or static load for an extended period.

Torque
measure of the effort of a body to rotate.