Two Cases of Rhabdomyolysis After Training With Electromyostimulation by 2 Young Male Professional Soccer Players

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Abstract: We report 2 cases of enormously elevated creatine kinase (CK) activity after training with electromyostimulation (EMS) by 2 young male professional soccer players. In one of them, a single training session with EMS caused exercise-induced rhabdomyolysis with a maximal CK activity of 240 000 U/L. These cases illustrate that unaccustomed EMS exercise may be harmful and can cause rhabdomyolysis even in highly trained athletes and even after 1 single session. Thus, EMS has to be conducted carefully especially by individuals who are known to frequently show notable increases in CK activity even after modest training stimuli. We suggest that EMS should not be applied as sole training stimulus and should not be conducted by strength training beginners. Furthermore, we recommend controlling plasma CK activity and urine color for beginners with EMS when they report strong muscle ache. Athletes with signs of rhabdomyolysis after EMS should be brought to hospital for monitoring of renal function and possible further treatment.

Key Words: rhabdomyolysis, electromyostimulation, soccer, creatine kinase

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INTRODUCTION

It is known that exhaustive exercise can induce exercise-induced rhabdomyolysis (ER), especially in unfit adults or those unaccustomed to a certain type of exercise.[1–6] Furthermore, it has previously been described that electromyostimulation (EMS) can induce muscle damage characterized by histological alterations of muscle fibers and connective tissue leading to elevated serum creatine kinase (CK) activity.[7] The aim of this case report is to increase awareness that unaccustomed EMS exercise as whole-body training may be harmful and can cause rhabdomyolysis even in highly trained athletes.

CASE SERIES

We report 2 cases of enormously elevated CK activity after training with EMS by 2 young male professional soccer players.

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Whole-body EMS training enables simultaneous activation of up to 18 regions or 12 muscle groups (both upper legs, both upper arms, buttocks, abdomen, chest, lower back, upper back, latissimus dorsi, and 4 free options) with selectable intensity for each region.[8,9] The 2 subjects in our case report performed a 20-minute EMS program at 3 EMS stations under the supervision of a certified instructor. Strain or current intensity was individually selected and modified during EMS session. Because of regional and individual disparities in current sensitivity, we are unable to prescribe the exact stimulation intensity in milliamperes. Electromyostimulation was applied during slight movements, with low amplitude performed without any additional weights in a standing position.

CASE 1

A professional German first league soccer player (men: 19-year-old, 176 cm, 70 kg) performed a training session of about 20 minutes in the morning with an electric muscle stimulator as whole-body training. In the afternoon, he completed regular team training and the following day he conducted the final team training before the next match. During these 2 latter training sessions, the player suffered from modest muscle pain primarily in the gluteal muscles. The following day in the afternoon, his team had a match in the first German soccer league and the player replaced a teammate in the second half and played for about 40 minutes. After the match, he noticed dark urine and reported severe muscle pain in the gluteal and femoral regions. He was assigned to a hospital, and erythrocyturia (250/μL) and proteinuria (150 mg/dL) were noted. Laboratory examination of the blood revealed a largely elevated CK (max. 240 000 U/L; reference level, <370 U/L), myoglobin (6764 ng/mL; reference level, 16-76 ng/mL) and lactate dehydrogenase (2935 U/L; reference level, 135-225 U/L). The remaining values including creatinine (1.04 mg/dL; glomerular filtration rate 97 mL/min) were within the normal range. There was no history and no clinical signs of a compartment syndrome. The soccer player was taken to the intensive care unit (ICU), and intravenous fluids (6-13 L electrolyte solution per day) were administered besides oral intake (6-15 L per day) for 4 days. The urine excretion was between 13.1 and 14.6 L per day.

The elevated blood values decreased rapidly, and the urine became physiologically clear again. Creatine kinase dropped to 95 752 U/L within 12 hours and to 62 880 U/L within 24 hours, respectively, under the described treatment. Three days later, laboratory investigations of blood and urine were close to normal, and the patient was discharged from the ICU. Intravenous infusions were reported to the National Anti-Doping Organization, and the athlete received an approval for his application for a retrospective therapeutic use exemption.

CASE 2

A 17-year-old member of the German U17 national soccer team (72 kg, 184 cm) completed a strength training during the mid-season break in a gym. Thereby, he performed 3 sessions of about 45 minutes with conventional strength training, and after a break of 10 days 1 training session of about 20 minutes with an electric stimulator as whole-body training. The following days after the EMS training, he suffered from modest muscle ache in the femoral region. Four days later, in the context of a routine examination by the national U17 soccer team, his blood values showed a heavily elevated CK (30 170 U/L) and an elevated aspartate aminotransferase (896 U/L) and alanine aminotransferase (254 U/L). The remaining values including creatinine (0.73 mg/dL) were within the normal range. The urine was normally colored, but screening with urine stix revealed minor proteinuria. The athlete reduced his training intensity for several days, but no specific treatment was required. Ten days later, CK (135 U/L) and all other examined values were normal again. At no time, the soccer player suffered from relevant muscle ache or was limited in his physical performance. Of note, the subject had CK values between 114 and 549 U/L in 5 different blood examinations throughout the preceding season and thus within normal limits of professional soccer players.[10]

DISCUSSION

To the best of our knowledge, these are the first reported cases indicating that highly trained professional soccer players may develop a rhadomyolysis after 1 single training session with such a device. Electromyostimulation training is frequently used in competitive sports in addition to regular resistance training to increase motor unit recruitment or instead of regular training because it is less time consuming.[11,12] Acute ER represents a kind of skeletal muscle injury that results in the release of myoglobin and other cellular contents into the blood circulation.

Electromyostimulation has the potential to induce muscle damage characterized by histological alterations of muscle fibers and connective tissue and leads to elevated serum CK activity.[7] The muscle damage induced by EMS isometric contractions has been reported to be even greater than by maximal voluntary isometric contractions despite a lower torque output.[7,13] The reason may be that higher stress is imposed on the activated muscle fibers because of the specificity of motor unit recruitment in EMS.[13]

The 2 cases reported here clearly demonstrate the alarming fact that massive CK activity elevation of the documented dimension and ER can be induced by 1 single training session with EMS. It has been shown that in pediatric trauma patients, CK values of 3000 IU/L or greater pose a significant risk for acute kidney injury.[14] In our case report, the athletes were young professional soccer players, and EMS may even be carried out by younger athletes. In another case, it has been shown that a 39-year-old man with rhabdomyolysis after strenuous exercise and alcohol abuse suffered from acute renal failure with a CK activity of only 26 320 U/L.[15]

It is known that soccer players frequently have higher CK values because of game-specific movements with a stop-and-go character and many direction changes, which impose high eccentric biomechanical strain on the working muscles leading to microinjuries and the release of CK from the cytosol.[16,17] For elite soccer players, it has been shown that the 95% confidence interval for CK is between 83 and 1327 U/L in the course of a season.[10]

Furthermore, some athletes show overproportionate CK increases after training stimuli, which may be caused by a higher permeability of muscle cell membranes.[17] There is evidence that some ethnic groups are more frequently affected, and athletes with a high percentage of fast twitch (type II) muscle fibers may also tend to have higher CK values after the exercise.[18] The 2 soccer players in our case report were both whites, and it can be assumed that they are no such "high responders." At least they were found to have normal CK values of professional soccer players in several blood samples during the regular season.[10]

It is remarkable that the strongly elevated CK value in the second case was not associated with strong muscle ache, even though it can be assumed that the CK elevation is induced by microinjury of the trained muscle.

These cases illustrate that unaccustomed EMS exercise—at least when carried out as whole-body training—may be harmful and can cause rhabdomyolysis even in highly trained athletes such as professional soccer players and even after 1 single training session.

TAKE HOME MESSAGES

- Electromyostimulation should not be applied as a sole training stimulus particularly by children and adolescents, strength training beginners, and athletes with known proneness to increased CK values after physical activity
- High athletic status does not generally prevent ER from EMS training
- Controlling plasma CK activity and urine color is recommended for beginners with EMS when they report strong muscle ache. But, it has to be considered that enormously elevated CK values can also occur without strong muscle ache
- Athletes with signs of rhabdomyolysis after EMS should be brought to hospital for further treatment. Monitoring of renal function and ER serum indicators is recommended
- Highly increased CK values in elite soccer players or in athletes with similar activity pattern should not be uncritically attributed to discipline-specific training and competition alone. "Modern" resistance training methods like EMS should also be taken into account and been asked for during history taking.

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