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EFFECTS OF MASSAGE UNDER HYPOXIC CONDITIONS ON EXERCISE-INDUCED MUSCLE DAMAGE AND PHYSICAL STRAIN INDICES IN PROFESSIONAL SOCCER PLAYERS

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ABSTRACT: Reports based on experiences from masseurs and players, mostly without any scientific background, suggest that the combination of a classical regeneration method (i.e. massage) with exposure to hypoxia may enhance regeneration in soccer. The aim of this study was to evaluate whether this specific combination could affect blood parameters related to muscle damage and physical strain after a soccer game. Approximately 15 hours after two separate championship games, 10 professional male outfield players of the first Austrian division were exposed to normobaric hypoxia (F_iO_2 13.5% ~ 4000m) or normoxia for 1 hour (30 minutes rest followed by 30 min massage) (cross-over design). Creatine kinase (CK), urea and uric acid (UA) were measured 4 days before the first game, and 15 and 63 hours after the two games. Match play increased CK values independently of the intervention. No effect of the massage in combination with hypoxia was seen. A trend was found between Δ UA ([UA] 48 hours after exposure minus [UA] before exposure) in response to hypoxia and SaO_2 measured in hypoxia ($r=0.612$, $p=0.06$). Results show that massage under hypoxic conditions had no additional positive effect on the measured parameters compared to massage alone. Solely the trend of a relationship for Δ UA and SaO_2 might indicate that redox alterations are a potential consequence of hypoxic exposure.

KEY WORDS: recovery, high altitude, football

INTRODUCTION

Physical strain during a soccer game or training is high [3,6] and effective recovery strategies, beside others (e.g., adequate training per se), are important factors to maintain the best performance capacity. Reports based on prior experiences suggest that the combination of a classical regeneration method (i.e. massage) with hypoxia might enhance the positive effects described for massage on its own [4]. Anecdotal reports from masseurs suggest more favourable massage effects under hypoxic conditions. Also soccer players report recovery to be superior under hypoxic conditions. From a scientific point of view, it could be argued that due to the effect of hypoxia on vasodilatation [8] and the concomitant increase in blood flow, muscle repair and regeneration could be facilitated. Hypoxia therefore could amplify the effect on blood flow shown for massage on its own [4]. Additionally, it was shown that already a single hypoxia session (4000 m) of approximately 80 min increased erythropoietin (EPO) levels by 67% [5]. After returning to normoxia further increases were seen for 1.5 hours and only after another 3 hours did EPO levels decrease, with an average half-life of 5.2 hours [5]. Increased EPO levels might have a positive effect on recovery as EPO was suggested to protect against adverse effects of free radicals and to have potentially anti-inflammatory and antiapoptotic properties [7]. Furthermore, EPO is assumed to promote tissue repair following various stresses due to the recruitment of vascular progenitor cells [7]. Therefore, it could be speculated that hypoxia could actually influence recovery processes after physical stress.

The aim of this study was to evaluate whether the combination of massage and hypoxia influences recovery after a soccer game by investigating blood parameters related to muscle damage and physical strain.

MATERIALS AND METHODS

Ten professional male outfield soccer players (age: 27.4±4.5 years, height: 180.4±7.0 cm, weight: 76.5±7.4 kg) of the first Austrian division gave written informed consent to participate in the single-blinded, placebo-controlled, cross-over investigation. One player dropped out after having performed half of the study protocol. Therefore, the sample size of the outcome measures differs (9 to

10 players). The study was carried out in conformity with the ethical standards outlined within the 1975 Declaration of Helsinki and was approved by the Review Board of the Department of Sport Science of the University of Innsbruck (Austria). During the study period, players performed two championship games, played one week apart from each other. Mean playing time of the players during the games was 84±10 and 87±8 min ($p>0.05$). Approximately 15 hours after each game players rested for 1 hour (30 minutes passive exposure followed by 30 minutes of massage) either at a simulated altitude of 4000 m (FIO_2 of 13.5%) or under placebo conditions (approximately 700 m, Innsbruck) in a normobaric hypoxic chamber (Low Oxygen Systems, Germany). After the first game 5 players were exposed to 4000 m and 5 players to 700 m; after the second game the order was reversed (cross-over design). Creatine kinase (CK), a marker of muscle damage [1], urea, a marker of amino acid breakdown [1] and uric acid (UA), a marker of enhanced nucleotide cycle turnover and an indirect marker of oxidative stress [1,2], were measured in capillary blood taken from the fingertip by the Reflotron Sprint (Roche Diagnostics, Austria). Measurements were taken 4 days before the first game (baseline) and approximately 15 hours (i.e. before hypoxic exposure) and 63 hours after the games (i.e. approximately 48 hours after the hypoxic or normoxic exposure). This time schedule was selected because muscle damage and physical strain indices were shown to be elevated up to 72 hours after a soccer game [2]. Oxygen saturation (SaO_2) was measured by finger pulse oximetry (Onyx, Nonin Medical, USA) after 30 minutes of hypoxia. After both games players had their usual post-game diet and performed their usual post-game training programme. After testing for normal distribution (K-S-test) paired Student t tests were used to identify changes over time and differences between interventions (Δ values, calculated as values measured 48 hours after the exposure minus values before the exposure). A Pearson correlation analysis was performed for oxygen saturation values and Δ values. Results are presented as means ± SD. Significance level was set at $p\leq0.05$.

RESULTS

Table 1 shows values for CK, urea and UA in the course of the study. CK values were increased after both games but returned to baseline 63 hours after the games. Urea was increased before the placebo exposure. No statistically significant differences between hypoxic and normoxic conditions were detected, except for SaO_2 values (84±6% vs. 96±2%, $p<0.001$). A trend was found between Δ UA in response to the hypoxic exposure and SaO_2 after 30 minutes of hypoxia ($r=0.612$, $p=0.06$), indicating that lower SaO_2 values were associated with larger decreases in UA.

DISCUSSION

The results indicate no beneficial effects of massage under hypoxic conditions on the measured parameters compared to massage alone. Only a trend of a relationship for Δ UA and SaO_2 may indicate a potential favourable effect of hypoxic exposure on the redox state. During high intensity exercise the purine nucleotide system is highly active, generating UA and O_2^- radicals [2]. Thus, it could be speculated that increased EPO levels, which enhance more with increasing hypoxia stimulus [5], might have had a protective effect against these free radicals [7].

Some critical points have to be outlined. Data show that urea and UA values were within the reference range and were not affected by the match play. Additionally, CK values already returned to baseline within 63 hours after the games (Table 1). These indicate complete recovery, at least for the measured parameters, and contradict Ascensao et al. showing that UA and CK were elevated for 72 hours after a game [2].

The procedures used in the present investigation correspond to the standard practice done by the soccer team (i.e. massage the day after the game). By doing so, the dose of hypoxia (i.e. 1 hour) may have been too low. The question arises whether more and regularly implemented sessions would have had additional effects. Furthermore, only a limited set of parameters was tested. Therefore effects on other parameters (e.g., oxidative stress) cannot be excluded.

TABLE I. VALUES FOR CREATINE KINASE (CK), UREA AND URIC ACID (UA) IN THE COURSE OF THE STUDY

	Reference range	baseline	before exposure (FiO_2 13.5% ~ 4000m)	48 h after exposure (FiO_2 13.5% ~ 4000m)	before exposure (normoxia)	48 h after exposure (normoxia)
		n=10	n=10	n=10	n=9	n=9
CK ($U \cdot l^{-1}$)	10-80	82.7 ± 27.5	215.9 ± 94.5#	84.7 ± 31.5*	210.6 ± 83.4#	92.0 ± 47.0*
UREA ($mg \cdot dl^{-1}$)	<50	43.2 ± 11.1	44.2 ± 12.8	42.6 ± 10.7	47.3 ± 5.8	41.9 ± 5.5*
UA ($mg \cdot dl^{-1}$)	<7.0	5.7 ± 0.9	6.0 ± 0.9	5.9 ± 1.1	5.7 ± 0.8	5.6 ± 0.9
ΔCK ($U \cdot l^{-1}$)			-131.2 ± 80.0		-118.6 ± 55.8	
ΔUREA ($mg \cdot dl^{-1}$)			-1.6 ± 6.1		-5.3 ± 5.5	
ΔUA ($mg \cdot dl^{-1}$)			-0.1 ± 0.6		-0.1 ± 0.3	

Note: * significantly different from before, # significantly different from baseline, Δ calculated as values measured 48 hours after exposure minus values before exposure

CONCLUSIONS

In conclusion, this study demonstrated that the combination of massage and hypoxia does not show an additional benefit with respect to regeneration compared to massage alone.

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Conflict of interest: none

REFERENCES

1. Andersson H., Raastad T., Nilsson J., Paulsen G., Garthe I., Kadi F. Neuromuscular fatigue and recovery in elite female soccer: effects of active recovery. Med. Sci. Sports Exerc. 2008;40:372-380.
2. Ascensao A., Rebelo A., Oliveira E., Marques F., Pereira L., Magalhaes J. Biochemical impact of a soccer match – analysis of oxidative stress and muscle damage markers throughout recovery. Clin. Biochem. 2008;41:841-851.
3. Bangsbo J., Mohr M., Krustrup P. Physical and metabolic demands of training and match-play in the elite football player. J. Sports Sci. 2006;24:665-674.
4. Best T.M., Hunter R., Wilcox A., Haq F. Effectiveness of sports massage for recovery of skeletal muscle from strenuous exercise. Clin. J. Sport Med. 2008;18:446-460.
5. Eckardt K.U., Boutellier U., Kurtz A., Schopen M., Koller E.A., Bauer C. Rate of erythropoietin formation in humans in response to acute hypobaric hypoxia. J. Appl. Physiol. 1989;66:1785-1788.
6. Gatterer H., Faulhaber M., Patterson C. Real time VO_2 measurements during soccer match-play. J. Sports Med. Phys. Fitness 2010;50:109-110.
7. Joyeux-Faure M. Cellular protection by erythropoietin: new therapeutic implications. J. Pharmacol. Exp. Ther. 2007;323:759-762.
8. Tamisier R., Norman D., Anand A., Choi Y., Weiss J.W. Evidence of sustained forearm vasodilation after brief isocapnic hypoxia. J. Appl. Physiol. 2004;96:1782-1787.